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THE PRODUCTION OF SEED OF ROOT CROPS AND VEGETABLES

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INTRODUCTION AND SUMMARY

Among the numerous readjustments that have had to be made since 1939 in agricultural production in countries outside Europe, those concerned with the supply and distribution of seeds of agricultural and horticultural plants demand an important place. Isolation from the former seed producing countries of central Europe and the great risks affecting the transport of consignments of seed across the seas from one country to another have led to the attempt to achieve self-sufficiency in seed supplies in all countries where production is at all possible. This development is probably more marked with respect to seeds of root crops and vegetables than with any other seed. New areas have had to be located which are best suited to this type of production, new techniques have had to be studied and passed on to the cultivators, and attention has had to be given to the choice of adapted varieties and to the distribution and marketing of the final product.

This publication describes these new developments in as many countries as have been accessible under present abnormal conditions. The various articles describe the extension of the production of seed away from the areas where conditions especially favoured this industry to countries less suited in many cases, and in some cases, for example, Scotland, Sweden and Canada, to countries actually on the fringe of the possible seed producing latitudes.

Because of the very recent nature of these developments, most of the individual accounts are actually only progress reports, indicating to what extent it is thought or has been found that seed can be produced, and the methods that are being adopted.

The creation of the sugar beet industry in the U.S.A. market is the most complete story published in this account. From absolute dependence upon imported seed in 1932-4, the American agronomists, by making full use of modern advances in plant breeding and physiology have now created an entirely new industry capable of meeting domestic needs.

It has already been shown that it is possible to produce the seed of a large number of vegetables in Sweden.

In Great Britain considerable progress can be noted; although Scotland appears to be outside the limits of economic seed production for all but a few vegetable crops, in England considerable advance has been made towards determining areas in which maximum seed production can reasonably be expected.

Production is also quite practicable in Australia, New Zealand and Canada, provided areas are chosen which give the requisite conditions for growing, ripening and harvesting.

An interesting development is the investigation into the possibilities afforded by the tropical highlands and by those parts of the Empire which lie in the Mediterranean basin.

There is little doubt that all these countries can become self-supporting as regards their seed requirements, and that producers can readily acquire, if they do not already possess, a knowledge of the particular techniques that have to be employed in this specialized branch of agricultural and horticultural production. The techniques that are being adopted for a wide range of vegetables and root crops under many different conditions are described in detail in a number of the articles in this symposium. There is also much information on the varieties used, on seed laws and regulations and at least an indication of the way in which plant breeding and developmental physiology may be used to increase production, improve quality, and assist in the selection of appropriate environments, and in the movement of varieties from one latitude to another.

No attempt has been made to give comprehensive lists of literature references, although certain key papers have been indicated in the appropriate sections. Specialists or members of recognized scientific institutions who are in need of more complete references to the literature on any given section, or of more detailed information on special points, are invited to apply to the Imperial Agricultural Bureaux, and the appropriate Bureau will deal with the enquiries to the best of its ability.

The Bureaux concerned would like to take this opportunity of expressing their deep appreciation of the co-operation received from all those who have assisted in the preparation of the present publication : firstly those who have contributed articles, and secondly those who by their ready help or advice have done so much to make possible the collection and publication of this material.

SUPPLIES

In peacetime practically the whole root seed requirements of the United Kingdom and Eire were grown in England and sufficient was exported to satisfy most of the requirements of New Zealand and Australia. Root seeds were also exported in considerable quantities to South Africa, the U.S.A., Canada and the Scandinavian countries. A notable exception was sugar beet seed, a large proportion of which was imported from the big sugar beet seed firms of Europe. Some rape seed was imported from Holland and also seed of special varieties of *Brassica* from Denmark and Holland.

In pre-war days the United Kingdom had an export trade in vegetable seeds of the order of £150,000 per annum whilst imports were around £250,000. Our requirements of cabbage, savoy, brussels sprouts, radish, celery and parsley were mainly grown in England. Peas, broad beans, runner beans, broccoli, parsnip, lettuce, cress and spinach were partly grown at home and partly imported. Dwarf beans, cauliflower, carrot, onion, leek and marrow were mainly grown abroad.

As a result of fluctuations in demand, and in acreage and yield of home seed crops, the overseas trade in seed was subject to wide variations. A valuable function of the import trade was the adjustment of available supplies, necessitated by these fluctuations.

Consequent on the increased demand for seeds as a result of the food production campaign, and of the cutting off of supplies from European and North African sources, other sources of supply have been developed, and there has been a large expansion in home production.

STRUCTURE OF THE SEED INDUSTRY

Organization

Before the war the seed trade was conducted by firms whose individual method of business had successfully maintained a good supply of seeds either by home production or by importation from abroad. Very little official organization or supervision was necessary at that time but with the outbreak of war and the consequent serious interruption in supplies it was necessary for the Government to assume more active responsibility, and to attune requirements, arising out of the largely increased production of human and animal foods, to the general war policy.

(*a*) *Trade Organizations.* There were a number of trade associations but by no means all the seed merchants belonged to an association. With the outbreak of war the functions of these associations became much more important and during the last few years there has been a greatly increased membership. The Government has invited associations to nominate representatives on all Government committees which have been dealing with seed problems and these members have voluntarily given up a great deal of time to assist in the organization of the trade under wartime conditions. The principal associations are :—

The Agricultural Seed Trade Association, the Wholesale Root and Vegetable Seeds Committee (Horticultural Trade Association), The Horticultural Trade Association, The British Sugar Beet Seed Producers' Association, The National Association of Corn and Agricultural Merchants, The Scottish Nursery and Seed Trade Association, and the Northern Ireland Ryegrass Machiners' Association.

The diverse interests of the seed traders of this country have not enabled them to form a single association, but if it could be done it would greatly assist in the formulation of a constructive policy on the problem of seed supply.

(*b*) *Growers' Organizations.* The National Farmers' Union is concerned with the interests of both the grower and the user of seeds and recently a separate Seeds Committee has been set up by the Union. Representatives of the Seeds Committee have been invited by the Government to take part in many conferences on seed problems and to elect representatives on Government committees. In some counties the county branch of the N.F.U. has also set up a seeds sub-committee to advise members on seed problems.

In addition to the interest of the N.F.U. a number of Seed Growers' Associations have been formed. Several of these have been in existence for a number of years and whilst the earlier ones were interested in the production of herbage seed some of the more recently formed associations have sections which deal with problems relating to root and vegetable seed production.

A Federation of Seed Growers' Associations was formed in 1937 by the Essex, Hereford and South Western Seed Growers' Associations and at the time of writing this Federation is considering the extension of its scope to embrace all Seed Growers' Associations.

(*c*) *Official Organizations.* A sufficient supply of seeds of good quality is a matter of national interest, and is therefore ultimately the responsibility of the Government; the departments immediately concerned are the Ministry of Agriculture and Fisheries for England and Wales, the Department

of Agriculture for Scotland and the Ministry of Agriculture for Northern Ireland. Liaison is maintained between these departments. They are responsible to Parliament and are the connecting link with the other bodies already mentioned.

In 1941 the Seeds Import Board was set up to take over responsibility for the distribution of all seed imported on Government account and to act as an advisory body to the Government Departments in all questions relating to the import requirements of the United Kingdom. The Seeds Import Board is a company limited by guarantee with directors and members representing the seed trade ; its function can be illustrated with reference to Lease-Lend supplies from the U.S.A. Estimates of seeds required by the United Kingdom are prepared by The Seeds Import Board and when approved by the Government Department particulars are transmitted to the U.S.A. where purchases are made by the United States authorities. The seeds are shipped to the United Kingdom and distributed here on behalf of the Ministry of Agriculture and Fisheries by the Seeds Import Board which submits offers of the seeds to an approved list of wholesale distributors at prices fixed by the Government Department. The seeds are then distributed through the normal trade channels. Full details of its working are outside the scope of this bulletin.

In England and Wales the main body concerned with technical problems relating to seeds is the National Institute of Agricultural Botany (acting Director Dr. H. Hunter, M.A., D.Sc.), governed by a council which includes representatives of the Fellows of the Institute, the Ministry of Agriculture and Fisheries, and of other bodies including the National Farmers' Union, Royal Agricultural Society England, the Seed and Allied Trades. There are three divisions of work —(1) The Crop Improvement Branch which carries out varietal trials and the multiplication of pure stocks of both new and old established varieties ; (2) The Official Seed Testing Station which provides a testing service in respect of analytical purity and germination for England and Wales and also deals with questions of seed-borne diseases and cognate problems ; (3) The Seed Production Committee which was set up in April 1942 at the request of the Ministry of Agriculture and Fisheries to stimulate and co-ordinate home production of seeds. This committee is composed of representatives of the Council of the National Institute of Agricultural Botany, of seed growers and the National Farmers' Union and the various trade organizations, with Sir William Gavin (Agricultural Adviser to the Minister of Agriculture) as Chairman. The executive and technical staff of this committee is housed in the Institute.

While the English reader will be familiar with the County War Agricultural Executive Committees, it should be explained for the benefit of others, that a War Agricultural Executive Committee, nominated by the Minister of Agriculture, has been in operation in every administrative county in England and Wales since the beginning of the war. Under the Defence Regulations these bodies have wide executive powers, enabling them to put into effect in the counties the agricultural policy of the nation ; a small but essential part of that national policy is increased home production of seeds and these County Committees play a very important part in this sphere.

Operation

The varieties of roots and vegetables grown in this country have been evolved after a long period of intensive and careful selection and in consequence if the seed grower is to maintain the quality of his seeds, he must always start with seeds obtained from plants that have been specially selected.

Although there are a few growers and workers at research institutes who breed selected stocks from such crops as brussels sprouts, cabbages, savoys, onions, etc., and raise seed of these stocks, the majority of the stock seed is produced by the seed merchants, and they supply it to growers with whom they make contracts for the seed produced. It has been the usual practice for root and vegetable seeds to be grown under contract, but at the same time there are some growers who prefer to grow crops " free " or without a contract. Under the Growing of Seed Crops (Control) Order 1943, contracts must be made for all seed crops, except peas, beans, onion, leek, lettuce and cauliflower, and the growing of " free " crops of the kind scheduled in this Order will no longer be allowed. In peace time merchants placed contracts not only at home but in France, Italy, Holland, Hungary, North Africa and even as far afield as the U.S.A., Canada, New Zealand and Australia, Kenya and Tanganyika.

The division of the seed trade into growers, wholesalers and retailers is not at all well defined, and it is not uncommon to find traders functioning in all three capacities. In addition there are agents who may be farmers engaged in work which brings them in touch with farmers willing to grow seeds. These agents arrange contracts with farmers for wholesale firms whose business is in London or remote from the seed growing areas. Contracts for vegetable seed crops tend to be for small acreages, partly because neither merchants nor growers like to have too much of any one crop in one piece and also because they are more suitable for the small farmer. With root seed crops contracts are made for larger acreages and 20 to 25 acres or more of one crop may be grown by one farmer. In peace time farmers and merchants fixed their own terms. Since the war, however, contract prices have been agreed nationally by

negotiations between representatives of the growers and the seed merchants, subject to the approval of the Ministry of Agriculture.

Seed Growing Districts

(*a*) *Essex.* Root or vegetable seed crops are grown to a considerable extent in the central arable region of Essex, but it is the Kelvedon district lying in the triangle Braintree, Maldon and Colchester, which is the seed growing district *par excellence.*

The rainfall in Essex is low, the annual average being 23.5 inches, whilst the Thames estuary is one of the driest parts of the British Isles, with less than 20 inches annual average. The monthly distribution of the rainfall shows no outstanding differences compared with that of the rest of the British Isles.

The soil of the Kelvedon seed-growing district is characterised by Scarfe (**5**) as "a flat fertile apron of uniform boulder clay which disintegrates . . . into a deep fine medium loam." Nearly all the land is in arable rotation and stock farming is of negligible importance ; the 20 per cent of land which is under grass is mainly used for horses. There is a strong tendency to intensive cultivation of the market garden type, but wheat, barley and clover are grown in rotation.

The seed farms vary in size from smallholdings of a few acres up to holdings of several hundred acres. The output per acre is high, and the amount of labour required per acre is more than for most types of agriculture. Several seed firms have their own seed farms and trial grounds in the district and some carry on plant breeding. The regular growers have for many years arranged their cropping programmes by mutual agreement with a view to securing the necessary isolation.

(*b*) *Lincolnshire.* Second in importance to Essex is the seed growing district around the Wash, mainly on the fens of Lincolnshire but spreading into the adjoining counties of Norfolk and Cambridgeshire.

The climate is not markedly different from that of Essex. The average annual rainfall is slightly higher and in places slightly more rain falls in the summer six months than in the winter. The temperature range is slightly less than in the inland parts of Essex, but is nevertheless typical of the East of England, with a tendency to the continental type.

The fen soils fall into two types, "silt" and "peat" and it is on the "silt" that the seed crops are most frequently found. The "silts" are deep, uniform soils ranging in texture from light to heavy ; the light "silts" include some of the most valuable agricultural land in England.

The region is one of intensive arable cultivation with a heavy predominance of cash crops, and there is a large rural population. The growers range from smallholders to some of the wealthiest farmers in England.

The crops that are grown for seed in the Lincolnshire and the Wash areas are sugar beet mangold, turnip and swede, peas, mustard and rape. The vegetable seed crops are grown only to a small extent.

(*c*) *Bedfordshire.* The well known market garden area around Biggleswade and Sandy, which lies on a strip of green sand and valley gravels, noted for its fertility, is another recognized vegetable seed crops area. In other parts of the county, mangold, sugar beet and peas are also a normal seed crop on many farms.

(*d*) *Kent.* Mention should be made of the well known Romney Marsh district in Kent, where seed crops of swede, broad beans and many others are grown.

Whilst there are isolated growers of root and vegetable seeds in many parts of the country, there are relatively few outside the Eastern area. Notable exceptions are Devon and Cornwall where seeds of early varieties of broccoli are grown, and Lancashire where there is a considerable production of cabbage and savoy seed by vegetable growers in the Ormskirk district, many of whom have their own, jealously guarded stocks. On a much smaller scale, many allotment holders in the north-east grow seed of their own selected exhibition leeks.

Since the beginning of the war there has been an increase in the number of market gardeners and nurserymen growing small acreages of vegetable seed for their own use or for sale. Information on these crops is scanty, but they do make a useful though not large contribution to the volume of seed production.

LEGISLATION

The Seed Act, 1920

Only a brief account of this Act will be given here, as A. W. Monro has given elsewhere (**3**) a clear and comprehensive description of its provisions and operation. Briefly, the Act lays down the principle that information as prescribed by the Regulations made under the Act including, among other things, the percentage purity (except for cereals) and the percentage germination, must be provided in respect of seeds sold for sowing. It prohibits the sale, or exposure for sale, and the sowing of seed containing more than a certain percentage of specified injurious weeds seeds ; apart from this it is no offence to sell seed of any quality provided the prescribed information is given. The Act applies to England and Wales and to Scotland, but only in part to Northern Ireland. Complete details of the control exercised under the Act are incorporated in Regulations made under the provisions of the Act, the regulations now in operation being the Seeds Regulations, 1922 (cf. Monro. *loc. cit.*). There are two amendments to the Seeds Regulations but they do not apply to the seeds being considered in this article.

One relates to Seed Potatoes, and the other to the use of Yorkshire Fog under certain conditions.

The information required in the case of vegetable and root seeds includes (1) the name and address of the seller; (2) a declaration that the seeds have been tested in accordance with the Act, i.e. at an Official Seed Testing Station, or at a licensed seed testing station, or in the case of garden seeds "in any other sufficient manner"; (3) the kind of seed; (4) the percentage purity by weight or a declaration that it is not below 97 per cent, (or 90 per cent in the case of carrot seed); (5) the total germination percentage by number or a declaration that it is not below the minimum authorized for the particular crop.

The administration of the Act and the regulations in England and Wales is the responsibility of the Ministry of Agriculture and Fisheries, and this work is carried out by the Ministry's own staff.

The Agricultural and Vegetable Seeds Order, 1941 (S.R. & O. 1941. No. 1393)

This Order applies to the United Kingdom and was made under Regulation 55 of the Defence (General) Regulations, 1939. It provides that except under licence granted by or on behalf of the Minister;—(*a*) no grower shall sell or offer to sell any seeds except to a seedsman licensed for the purpose of this Order; (*b*) no person other than a licensed seedsman shall import any seeds into the United Kingdom; and (*c*) no licensed seedsman shall buy seeds except from the grower thereof, an overseas seller or another licensed seedsman, or sell seeds except to a person buying them to sow or resell for sowing or to another licensed seedsman. The Order also provides that licensed seedsmen shall keep accurate records and furnish to the Minister by whom he was licensed such returns as are required. A schedule to the Order lists the kinds of seeds to which it applies which are as follows:—

SECTION 1—GRASS AND CLOVER SEEDS.
- Perennial Ryegrass
- Italian Ryegrass
- Mixed Ryegrass
- Cocksfoot
- Timothy
- Crested Dogstail
- Meadow Fescue
- Rough-stalked Meadow Grass
- Smooth-stalked Meadow Grass
- Chewings Fescue
- New Zealand Brown Top
- American Agrostis
- Broad Red Clover
- Late Red Clover
- Trefoil
- Alsike
- Alsike and White
- Dutch White Clover
- New Zealand White Clover
- Wild White Clover
- Lucerne
- Sainfoin
- Trifolium
- Yarrow
- Suckling Clover

SECTION 2—OTHER AGRICULTURAL SEEDS.
- Swede
- Turnip
- Mangold
- Rape (Agricultural)
- Marrow-stemmed Kale
- Thousand-headed Kale.
- Cabbage (Cattle)
- Carrot (Field)
- Parsnip (Field)
- Field Peas (Greys, Duns, Partridges and Maples)
- Tares or Vetches (Winter)
- Tares or Vetches (Spring)
- Sugar Beet
- Maize
- Linseed for growing for feeding purposes.
- Buckwheat.

SECTION 3.—VEGETABLE SEEDS.
- Carrots
- Onions (Lisbon)
- Onions (other than Lisbon)
- Peas (Except peas of types normally used after drying for edible purposes and commonly known as Harrison's Glory, Dutch Marrowfats, Lincoln Blues, and Small Dutch Blues).
- Broad Beans
- Runner Beans
- Leeks
- Parsnips.
- Rape (Horticultural)
- Beet
- Celery
- Lettuce
- Spinach
- Tomato
- Broccoli
- Cauliflower
- Garden Turnip
- Garden Cabbage
- Garden Savoy
- Garden Kale
- Garden Swede
- Brussels Sprouts
- Dwarf Beans

The effect of the Order is to bring into channels where they can be observed and if necessary controlled, the movements of the scheduled seeds.

The Growing of Seed Crops (Control Order, 1943. (S.R. & O. 1943. No. 571)

Made by the Minister of Agriculture and Fisheries under Regulation 55 of the Defence (General) Regulations, 1939.

This Order applies to England and Wales and concerns only the main root and vegetable seeds. The object of this Order is to ensure control over the acreage devoted to seed production of the seeds scheduled in the Order, so that provision may be made against any serious deficiencies and also to prevent land being used to grow crops that are not required. The method adopted is to make it obligatory on all persons, who are growing seed crops of the kind scheduled under the Order to arrange a contract with a licensed vendor by a

prescribed date, or to have obtained a special licence to grow the crop. If no contract is arranged or a special licence is not granted, the crops must not be left for seed for sale. The Order does not apply to crops of less than 0.25 acre.

The value of this Order will be appreciated if it is remembered that land and labour devoted to seed production are withdrawn from food production. The Order enables the Ministry of Agriculture to observe exactly the progress made in fulfilling the national target acreages set by the Seed Production Committee and to take action accordingly.

Both this Order and the preceding one are wartime measures.

GENERAL TECHNIQUE

Transplanting machinery

Transplanting machines developed in the first instance for market garden crops are being increasingly used for biennial seed crops. These machines are especially valuable under wartime conditions as they save labour. Many growers, however, still prefer to plant by hand, in such a way that the crop can be cultivated both along and across the rows.

Pest control

The effective control of insect pests on a large scale may require equipment and skill beyond the means of the average seed grower. Of special interest is a method of crop fumigation with nicotine vapour under a long gas-proof drag sheet. For seed crops the drag sheet and a small vapourizing device are attached to a specially designed high-clearance tractor which can be used for crops up to four feet high. This method is used for black fly on sugar beet seed (q.v.) and for cabbage aphis and pollen beetle on *Brassica* crops.

Harvesting and threshing

Most of the root and vegetable seed crops are cut and tied by hand because of the ease with which they shed their seed. With some of the less valuable crops, however, binders are sometimes used and of recent years the combine harvester-thresher has been used, e.g. for mustard.

The flail is still used in seed-growing districts for threshing small lots of vegetable seeds, whilst small threshing machines are popular with seed growers. An ordinary threshing machine is used for large crops of root seeds. An interesting practice still survives in Kent, where swede seed is frequently threshed by placing the dried plants between two sheets and then pulling a roller to and fro across the top sheet.

Seed drying

The keeping quality of a given type of seed under given conditions is inversely related to its moisture content, and depending on the temperature of storage, there is for each kind of seed a critical moisture content above which it is not safe to store it. In England it is not possible to rely wholly on the sun for drying seed, as for instance in California, and many seed merchants have installed plant to dry seed which is delivered with too high a moisture content.

One popular type is the Dinesen drier. In this drier hot air from a furnace is blown by a fan through ducts in the floor of a building. The ducts have numerous openings covered by wooden grids on which sacks of seed are laid; the hot air is thus forced to escape through the seed. The temperature of the air is regulated by a damper which controls the flow of cold air in the ducts. The reduction in moisture is observed by periodically weighing the sacks, and calculating the loss in weight. This method is still in use and is particularly good for drying small lots of different seeds, as there is no risk of the seeds getting mixed.

For drying large bulks of seed, when the question of changing from one type to another does not arise, drying plants of the types designed for grain drying are now in use. These may be of the conveyor, the tower or the cascade type. In all cases a continuous flow of seed is brought into intimate contact with a current of hot air and usually is finally cooled with cold air. The seed can then pass straight to the cleaning machinery by elevators. Most of these plants are difficult to clean.

The sooner seed can be dried after harvesting, the better, for as long as it is damp there is danger of deterioration and loss of germination. Attention is therefore being paid by the Seed Production Committee to the provision of drying facilities on or near the farm. Equipment for this purpose should be simple, without working parts, inexpensive, suitable for installation in existing buildings and capable of dealing with small bulks of different seeds. At the National Institute of Agricultural Engineering, Askham Bryan, York, designs for a simple type of tray drier to these general specifications are being considered.

The air temperatures used for drying seed rarely exceed 130°F. and if the seed is very wet the temperature has to be reduced to avoid injury to germination. In advising farmers on seed drying it is usual to recommend temperatures of 100°F. thus leaving a margin of safety. Typical moisture contents above which drying may be considered necessary are 10 per cent for *Brassica* spp., 15 per cent for *Beta* spp. and 14 per cent for peas and beans.

Moisture content is usually estimated by the ordinary method of drying to constant weight, but in recent years electrical moisture meters are coming into wider use.

VARIETIES

In 1942 the Ministry of Agriculture decided that a reduction in the number of varieties listed by seed merchants was desirable, and accordingly they asked the Seed Production Committee to consider the possibility of preparing a standard list of varieties. This standard list is designed to provide a range of varieties which should ensure a full supply of vegetables for the maximum period of the year in all parts of the United Kingdom. It also aims at the elimination of unnecessary varieties and synonyms.

It is not intended to prevent seedsmen from offering their own specialities or particular strains for special purposes, the aim being to provide a list of varieties of which adequate supplies will, it is hoped, be available and to which preference should be given when contracts for growing seeds are being placed at home or abroad.

The Standard List is intended to operate in respect of annuals after the 1943 harvest and in respect of biennials after the 1944 harvest.

Standard List

RECOMMENDED LIST OF STANDARD VARIETIES OF PEAS, BEANS, VEGETABLES AND ROOT SEEDS.

SEED PEAS
Round-Seeded Varieties
British Lion
Early Bird
Foremost
Meteor
Pilot
Superb
(For the Canning Trade)
Alaska

Wrinkled Varieties
Alderman
Duplex
English Wonder
Giant Stride
Gradus
Kelvedon Wonder
Lancashire Lad
Lincoln
Little Marvel
Lord Chancellor
Miracle (Sharpe's)
Onward
Pioneer
Progress
Senator
Thomas Laxton
(For the Canning Trade)
Canner's Perfection
Delicatesse
Surprise

BROAD BEANS
Longpods
Early
Johnson's Wonderful
Bunyard's Exhibition
Masterpiece Green
(For the Canning Trade)
Threefold White

Windsors
Four-seeded White
Four-seeded Green
(The Harlington types if Four-seeded not available)

RUNNER BEANS
Princeps
Prizewinner
Scarlet Emperor Types
Scarlet Ordinary

DWARF BEANS
Black Prince
Brown Dutch
Canadian Wonder
Comtesse de Chambord
Masterpiece
The Prince
(for the Canning Trade)
Keeney's Refugee Stringless Greenpod.

BEET
Long and Intermediate Varieties
Cheltenham Green Top
Nutting's Red
Intermediate or Obelisk (Nonpareil)
Round Varieties
Red Globe (Detroit Dark Red)
Crimson Globe

Beet, Green or Spinach

BORECOLE OR KALE
Cottager's
Dwarf Green Curled
Tall Green Curled
Hungry Gap
Marrow Stem Green
Thousand Headed.

BROCCOLI
Late Queen
Leamington
Lenten Monarch
June (Clucas)
June (Methven)
Purple Sprouting Early
Purple Sprouting Late
Roscoff Varieties
Snow's Winter
St. George (Clucas)
White Sprouting Early

BRUSSELS SPROUTS
LXXX (Harrison)
Evesham Types
The Wroxton
Cambridge Nos 1, 3 and 5
(Also Rous Lench as an early variety if desired)

CABBAGES
Pointed Varieties
Ellam's Early
Enfield Market
First and Best
Leeds Market
Offenham
Wheeler's Imperial
Winnigstadt
McEwan Types

Drumhead and Round Varieties
Brunswick
Christmas

January King
Primo
Red Drumhead
Robinson's Champion

CARROT
Chantenay Types
Early Nantes
James' Scarlet Intermediate
St. Valory

CAULIFLOWER
All the Year Round
Majestic
Snowball
Veitch's Autumn Giant and Self-protecting types.

CELERY
Clayworth Prize Pink
Standard Bearer Red
Wright's Giant White

CRESS
Plain

CUCUMBER
Ridge Varieties
Gherkin
Long Green

LEEK
Musselburgh or any standard varieties.

LETTUCE
Cabbage Varieties
All the Year Round
Arctic King Types
Cheshunt Early Giant
Feltham King
Iceberg
May King
New York or Wonderful
Tom Thumb
Trocadero Improved Green

Cos Varieties
Density
Lobjoit's Green
Paris White

MUSTARD
White

ONION
Ailsa Craig
Bedfordshire Champion
James' Longkeeping
Up-to-date
White Lisbon or similar
White Spanish or similar

PARSLEY
Curled

PARSNIP
Hollow Crown
Offenham

RADISH
Round Varieties
Scarlet Globe
Sparkler
Long and Half Long Varieties
Woods' Early Frame
French Breakfast

SAVOY
Best of All
Ormskirk Types

SPINACH
King of Denmark
Longstanding Giant Prickly
Longstanding Giant Round

TOMATO
It is difficult to standardise varieties but it is recommended that the most popular sorts be maintained according to the seller's style of trade.

TURNIP, GARDEN
Golden Ball or Stone
Manchester Market
Milan White
Purple Top Milan
Snowball.

SWEDE, GARDEN
Laing's

VEGETABLE MARROW
Bush Green
Bush White
Long Green
Long White

ROOT SEEDS.

SWEDE
Purple Top Varieties
Best of All
Eclipse Types
All Hardy Purple Top Types

Green and Bronze Top Varieties
Conqueror
Kangaroo
Wilhelmsburger
XL All

TURNIP
White Fleshed Varieties
Imperial Green Globe
Lincolnshire Red Globe
Purple Top Mammoth

Yellow Fleshed Varieties
Fosterton or Dale's
Green Top Yellow Aberdeen
Purple Top Yellow Aberdeen
The Bruce

MANGOLD
Globe Shaped Varieties
Giant Orange Globe Varieties
Yellow Globe Varieties

Intermediate and Long Rooted Varieties
Brock's Yellow Intermediate
Brock's Red Intermediate
Gatepost Yellow Intermediate
Golden Tankard
Mammoth Long Red
Orange Intermediate

ZONING

In the past, isolation between crops which might damage each other by cross-pollination, such as sugar-beet, mangel and red beet and also certain *Brassica* crops, has been arranged locally

ZONING SCHEME FOR MANGOLD SUGAR BEET AND GARDEN BEET SEED CROPS.

National Institute of Agricultural Botany.

when contracts were placed. In recent years there has been a very sharp increase in the English production of sugar beet seed and this increase has occurred mainly in regions where mangel seed production was already established. Since commercial practice requires an isolation of 1,000 yards between mangel and sugar beet seed crops, it became increasingly difficult to obtain isolation. As a result of these difficulties a voluntary zoning scheme in the district around the Wash was started by a group of merchants in 1941, defining certain zones from which either sugar beet seed or mangel seed crops were to be excluded by agreement. In 1942 zoning schemes were organized by the Seed Production Committee, in co-operation with War Agricultural Executive Committees and Seed Growers' Associations in Lincolnshire, Isle of Ely, Cambridgeshire, Norfolk, Essex, Bedfordshire and Huntingdonshire. All contracts were notified to the Seed Production Committee, the proposed crops were plotted on maps and any in the wrong zone or near a border were notified to the War Agricultural Executive Committee concerned, who arranged for the necessary adjustments.

The 1942 zones have been modified and extended for the crops for harvest in 1944 and the revised zones except those in Essex are shown in the map. For the most part the zones are only concerned with sugar beet and mangel seed crops. In Cambridgeshire and Essex, however, red beet zones are provided from which both sugar beet and mangel seed crops are excluded. In the remaining counties in which zoning operates, red beet may only be grown under licence from the War Agricultural Executive Committee; a licence from the W.A.E.C. is also required in all counties concerned before other types of *Beta vulgaris* (seakale beet, spinach beet or Swiss chard) may be grown for seed.

The beginning of zoning for *Brassica* seed crops is seen in the zoning scheme for Essex, to operate for the 1944 harvest and thereafter. In one of the zones in this scheme the growing of Hungry Gap, Marrow Stem, Thousand Head and Rape Kales for seed is prohibited.

METHODS OF CULTIVATION

Sugar beet, mangel and garden beet: Beta vulgaris

1. Sugar Beet. Sugar beet is the most recent addition to British root seed crops and now occupies the greatest acreage. Its importance in the national economy can be gauged from the fact that home grown sugar provides all the wartime domestic ration.

The production of sugar beet seed in this country is a more recent development than the production of sugar beet roots for the factory. In 1924 only 0.6 per cent of the seed used in the United Kingdom was English, in 1934 this had increased to 20.1 per cent, in 1938 to 40 per cent, and in 1939 to about 50 per cent, since which year the whole of the country's requirements have been produced in England. Previously sugar beet seed was imported from European countries, especially Germany, Holland, Sweden, Czecho-Slovakia, Denmark and Poland. At first English seed production consisted simply in the growing of seed crops from mother seed imported from the Continent. Certain English seed firms had agreements with continental firms, giving the English firm the right to handle in this country the varieties produced by the Continental firm. The next stage in the building of an English sugar beet seed industry was the production of mother seed from imported ante-mother seed, which is seed of the families that are bulked to form the basis of the strain. More recently breeding work has been started by certain firms and by the Cambridge University Plant Breeding Institute. The foundations are thus being laid for making the country entirely self-supporting in all stages of sugar beet seed production.

The different strains of home-produced seed have been extensively tested in variety trials by the N.I.A.B. and a summary of the results has been published (2).

The standard method of growing sugar beet seed in England is by transplanting. Nursery beds are sown in July or August at the rate of about 30 lb. mother seed per acre, the rows being 12 to 20 in. apart. One acre of nursery should give ample plants (stecklings) for 10 acres of seed crop. It is the commercial practice to allow not less than 500 yards isolation between crops of different varieties of sugar beet. Transplanting is done either in late autumn or in spring, before new growth starts. The ideal size for a steckling is about $\frac{3}{4}$ in. diameter, and when lifting the end of the root is cut off leaving 3-4 in. for planting; many growers also cut off about half the top of the plant. Common planting distances are rows 3 feet apart, plants 18 to 24 inches in the row or they may be planted "on the square" 2 feet by 2 feet. In Lincolnshire the crop usually follows potatoes and receives only a top dressing of about 2 cwt. sulphate of ammonia, but in other districts, where it more frequently follows corn, it may receive a dressing of farmyard manure or a compound fertilizer, followed later in the season by a top dressing with a nitrogenous manure. The stecklings are sometimes rolled after transplanting and the crop is horse-hoed until it grows too high.

To give support to the seed plants, the rows are often moulded up in May. Many growers practice "topping" of the young plants, that is removing the tip of the main stem when it is about knee high; this induces lateral branching which is

believed to lead to more even ripening of the seed. The crop is ready for harvest in September. It is usually cut by hand when about two-thirds of the seed is ripe and is tied into small bundles. These may either be laid on the stubble to keep them off the ground, or stooked. When the crop is dry enough, it is carted and built into small stacks, which are provided with ventilation and thatched. Since the seed sheds easily, it needs to be handled carefully; handling when wet is avoided and sheets to catch falling seed are frequently used when carting and stacking or threshing. The crop is threshed with the ordinary corn thresher and is often given a preliminary cleaning on the farm. An average yield is 14-15 cwt. per acre. When the merchant receives the seed he tests the moisture and if it is over 15 per cent he dries the seed before cleaning. Usually the seed is elevated straight from the drier to the ordinary type of seed cleaning machine which removes small seed, weed seed and dross by aspiration, blowing and sieving. From these it passes to belt machines where sloping belts moving rapidly upwards carry away any remaining light seeds and pieces of stalk while the good seed rolls and bounces to the bottom. Finally the seed is dressed with a mercurial powder.

The most important pest of sugar beet seed crops is black fly (*Aphis fabae* Scop.), which also attacks root crops of sugar beet and is the same species (though possibly a different race) as that attacking broad beans and field beans. The main alternative or winter host is the spindle tree (*Euonymus*). Investigations at Cambridge and in the Eastern Counties (**4**) have shown that winged forms appear on spindle trees in early May and produce primary infections on sugar beet in May and early June. From these, secondary infections on sugar beet arise in June. If not checked the pest may cause serious losses in yield by direct injury and by carrying virus disease. In root crops the primary infections may occur anywhere in the field, but in seed crops they are mainly found around the headlands and it is the secondary infection which affects the rest of the crop. The method of control suggested by the Cambridge workers is based on careful inspection from about May 20th onwards on the headlands and of two strips at right angles to each other across the middle of the field. If infection is confined to the headlands removal and destruction of all infected plant parts should be sufficient to ensure control and the same is true if less than 5 per cent of the plants in the middle of the field are infected. Otherwise fumigation of the crop with nicotine vapour is necessary. This is done by a firm of specialist contractors by arrangement with the British Sugar Beet Seed Producers' Association.

The cultivation of sugar beet either for roots or for seed is avoided in certain districts where the soil is known to be infected with beet eelworm (*Heterodera schachtii* Schmidt) and seed crops are preferably isolated from root crops to avoid infection by downy mildew and pollination by bolters.

2. Mangels. There are numerous types and strains of mangel, developed and maintained by individual seed firms mainly by mass selection. The types are classified by the shape (long, tankard, intermediate and globe) and colour (yellow, golden, orange and red) of the roots and are usually sold under these designations. Trials conducted by the N.I.A.B., 1936-38 (**1**) showed important differences in dry matter content between strains. These differences were not related to form and colour of the roots, except that Golden Tankards are uniformly high in dry matter content but low in yield of roots and of dry matter per acre.

The cultivation of mangel seed is the same as for sugar beet seed although mangel stecklings are considered to be less winter-hardy than sugar beet. The yield is similar and the agreed contract price is the same.

3. Garden Beet. Seed of garden beet is grown in the same way as the other types of *Beta vulgaris* but the acreage undertaken by individual growers is usually smaller. In transplanting the stecklings are usually placed closer than mangel stecklings. Garden beet seed is a more risky crop to grow and the agreed contract price is more than double that for sugar beet and mangel.

Brassicas

The dangers of contamination of *Brassica* seed crops by foreign pollen are shown in the Table which has been issued by the Seed Production Committee. The isolation distance customarily required where there is a danger of crossing is one mile.

Ability to cross-fertilize in the Genus Brassica.

SPECIES I. CABBAGE GROUP (*Brassica oleracea*) n=9

All varieties of Species I cross freely with one another, but not with varieties of any other species.

(Wild Cabbage)
Cabbage
Savoy
Brussels Sprouts
Cauliflower
Broccoli
Sprouting Broccoli (inc. Calabrese)
Kohl-rabi
Marrow Stem Kale
Thousand Head Kale
Scotch or Curled Kale
Hearting Kale
Russian Kale
Couve Tronchuda
Chou de Burghley
Cottager's

SPECIES II. SWEDE GROUP (*Brassica Napus*)
n=19
All varieties of Species II cross freely with one another and sufficiently freely with varieties of Species III, IV, and VII (B. Rapa, B. campestris and B. juncea) to make isolation necessary to ensure purity.
Swedes
Swede-like Rapes
(Dwarf Essex, English Giant, Broad leaved, Kangaroo, etc.)
Swede-like Kales
(Fill Gap, Hungry Gap, Asparagus, Rape Kale, Buda or Delaware Kale.)

SPECIES III. TURNIP GROUP (*Brassica Rapa*)
n=10
All varieties of Species III cross freely with one another and sufficiently freely with Species II, IV, and VII (B. Napus, B. campestris and B. juncea) to make isolation necessary to ensure purity.
Turnips
Turnip-like Rapes
Rübsen or Bird Seed Rapes

SPECIES IV. *Brassica campestris*
n=10
All varieties of Species IV cross freely with one another and sufficiently freely with varieties of Species II, III and VII (B. Napus, B. Rapa, and B. juncea to make isolation necessary to ensure purity.
Chinese Cabbage (like cos-lettuce) Pe-tsai (var. *pekinensis*)
Chinese Cabbage (like celery) Pak-choi (var. *chinensis*)
Tori Rape, Sarson } from India

SPECIES V. *Brassica alba*
n=12
Will not cross with any other species.
White Mustard

SPECIES VI. *Brassica nigra*
n=8
Will not cross with any other species.
Black or Brown Mustard.

SPECIES VII. *Brassica juncea*
n=18
This species will cross sufficiently freely with the varieties of Species II, III, and IV to make isolation from them necessary. Seed crops of Chinese Mustard must also be isolated from Black Mustard with which it will cross. Black Mustard however is not affected by the pollen of Chinese Mustard.
Chinese or Indian mustard

SPECIES VIII. *Brassica sinapistrum*
n=9
Will not cross with any of the above cultivated species.
Charlock

Brassica oleracea group

Cabbage, Savoy, Brussels Sprouts, Cauliflower, Broccoli, Kales (cf. also *Brassica Napus*), Kohl Rabi.

Seed of brussels sprouts is commonly grown from the stems of plants which have produced a vegetable crop. Where seed production is the primary object of the crop the plants will of course have been grown from "stock seed" and rogue plants will be removed before flowering occurs. Selected plants may be transplanted during the winter. Seed of brussels sprouts is normally sown in March or April, and the young plants transplanted about June, usually 3 ft. apart each way. Sprouts are picked from October to February and the plants run to flower early in the spring. The crop is ripe by late July or August and is usually cut by hand when the seed changes colour to a dark brown. If left too late the pods shatter easily and birds may do much damage. After cutting the crop is dried in small heaps on the ground. It may be threshed from the field but is more often stacked for threshing later.

Seed of cabbages and savoys is sometimes grown from the stems of plants which have produced a green crop, but more often it is produced from specially grown crops. Since the "heads" of cabbages stand the winter better if they are not too forward in growth, the seed is normally not sown until late spring. The seed is sown in nursery beds and the plants transplanted about the end of July. Formerly this was always done by hand but machine planters are now coming into favour. Cabbages and savoys are usually planted closer together than brussels sprouts but the distance varies to some extent with the variety. Medium sized garden varieties are often planted about two to the square yard either in wide rows or "on the square." The rows are sometimes "earthed up" in the autumn to give support to the plants and to assist in ensuring good drainage, a necessity if the plants are to overwinter well. Towards the end of the winter solid heads are slit into four with a knife in order to ease the strain when the flowering stalk lengthens. From flowering until threshing the treatment of cabbage and savoy is much the same as that described for brussels sprouts.

Kale, both garden and field, and broccoli, both heading and sprouting, are usually grown like normal green crops but are allowed to flower in the second year of growth. They may all be sown in nursery beds in the spring and transplanted about the same distance apart as cabbage, but field kales in particular are more usually drilled in the field in spring or early summer. Marrow stem kale may be "singled" but, like thousand head kale, is frequently left unthinned. Seed of both thousand head and marrow stem kale was in the past quite often grown from crops, of good strains, which were originally sown as fodder crops. Harvesting is similar to that described for brussels sprouts. Kale and purple sprouting broccoli usually survive the English winter but white sprouting and heading broccoli are frequently damaged and sometimes destroyed except in the extreme South and West.

Cauliflower is not normally grown for seed in

England. The early types are however sometimes grown, the seed being sown in the autumn and the young plants wintered under glass. If the weather is wet in late June and early July when the plants are still in curd there may be heavy losses from rotting and ripening is late—September or even October.

The yields of these crops may vary considerably, and the average yields given below can only be taken as a very general guide :

	cwt. per acre.
Cabbage	6
Savoy	7
Brussels Sprouts	5 to 7
Cauliflower	1
Broccoli, Heading	2
Sprouting White	4 to 5
Sprouting Purple	8
Kohl Rabi	2
Kale Marrow Stem	7
„ Thousand Headed	7
„ Garden	8

Cabbage aphis (*Brevicoryne brassicae*) may cause serious damage to *Brassica* crops, particularly to brussels sprouts, cabbage, cauliflower, broccoli and swedes. With seed crops the flowers and pods may be injured. Since seed crops are often a source of infection for green crops it is important to take measures to prevent the spread of the pest. Some growers spray their seed crops during May or dust with 3 per cent nicotine. If there are signs of aphis in early July, a dusting then with nicotine, and another at the end of the month is often carried out. In the vegetable growing districts of Bedfordshire, Cambridgeshire, Huntingdonshire and Hertfordshire the damage to green crops is so serious that Cabbage Aphis Orders were issued (S.R. & O. 1936 No. 120 & 1937 No. 6) which empower the local authority to order, on the recommendation of an appointed officer, that infected crops must be treated in a prescribed manner between February 15th and June 30th. If the occupier thus ordered does not carry out the treatment or bury or destroy the crop, he is liable to penalties.

An attack of Blossom or Pollen Beetles (*Meligethes aeneus*) reduces the yield of seed very considerably and if severe results in a complete loss of crop. Nicotine or derris dust applied before the flower buds open will control this pest. Once the flowers have opened, the beetles take refuge inside, and are less easily destroyed.

Brassica Rapa—Turnip.

Turnip seed crops usually follow potatoes, peas, beans or clover, rather than a white straw crop.

It is now usual to drill turnips for seed production where they are to stand rather than transplant them as with most other Brassicas. Seed is sown not later than the second week of September at 3 lb. per acre in rows 20 - 30 inches apart. In the spring a nitrogenous fertilizer is applied to the crop and plants are sometimes thinned about this time. Rogueing takes place when the crop is coming into flower. At that stage differences in flower and stem colour are distinguishable, and wrongly coloured plants are removed.

The seed begins to ripen from early July and to avoid shattering the crop is harvested before the change in colour of the seed is complete. The crop is usually cut with a binder and stooked till dry ; by this time the seed has darkened in colour. The sheaves are then either stacked or, in some cases, threshed straight from the field ; the latter course is not recommended because of the better condition of seed which has dried in the stack.

Turnips grown for stock seed are sown earlier, in seed beds in rows 12 - 20 inches apart. This allows time for well developed roots to form and the selected ones are transplanted. In this way good stocks are maintained. An average yield is 10 cwt. per acre.

Brassica Napus Group

Swede. Seed is sown in July or early August in seed beds with drills 12 to 20 inches apart, to give young plants for putting out in the Autumn or the following Spring. It is important to use seed from a stock clean of dry rot or canker (*Phoma lingam*), which is a seed borne disease. 1.5 to 2 lb. of seed provides enough plants for transplanting about one acre.

Young plants are set out during the winter months in rows 24 to 36 inches apart with 12 to 24 inches between the plants. Sometimes the plants are dibbled in every alternate furrow behind a plough, the plough being set to cut furrows about 10 inches wide. The young plants are planted fairly deeply as it is thought that shallow planting gives rise to canker and premature rotting of the root.

In early spring the crop is harrowed and rolled, and a good top dressing of nitro-chalk or sulphate of ammonia is customary.

The rows are ridged up in late spring (May) to give support to the plants. Rogueing is carried out when the crops are in flower, as with turnip.

The tough, thick stems produced by crops grown in this way have to be cut by hand, but otherwise harvesting and threshing are the same as for turnip seed.

The yield of swedes is not as reliable as that of turnip. The average yield is about 8 cwt. but much larger yields are not unknown.

Stock seed is grown in the same way as stock seed of turnip (cf. Also p 24 (Scottish article.)).

Rape: Rape for seed is drilled about June at 2-4 lb. to the acre in drills 15 to 18 inches apart and

treated in a similar manner to a turnip seed crop. A rape seed crop often follows a bare fallow. The seed crop is usually ready to harvest about early July. The average yield is about 10 cwt. per acre but good crops yield up to 20 cwt. per acre.

SWEDE-LIKE KALES. One group of kales, sometimes called "hybrid kales", belong to *B. Napus*. Apart from their isolation requirements they are cultivated for seed in the same way as rape.

Radish : Raphanus sativus

Varieties are kept well isolated as crossing occurs readily. This annual crop is commonly drilled where it is intended to grow, from mid-February to mid-April ; 10 to 20 lb. of seed per acre are required.

Harvesting takes place from mid-August onwards and the crop is cut with a binder. Stacking, threshing and dressing are much the same as with *Brassica* crops, but threshing is rather more difficult.

Flea beetles (*Phyllotreta* species) may attack the foliage as it is formed, and if severe may kill the crop. Applications of derris dust (0.2 per cent rotenone content), or nicotine dust (3 per cent nicotine) are effective methods of control.

Carrot : Daucus carota

Carrot is a cross pollinated crop and isolation between varieties is necessary as well as isolation from wild carrot. While the distance maintained between varieties is sometimes not more than a few hundred yards, isolation of at least one mile has been recommended for the growing of stock seed.

Carrot seed is usually produced from small roots or stecklings. For these, stock seed is drilled in seed beds from mid-July to August, 0.5 to 1 lb. of seed being sufficient to produce stecklings for an acre.

In autumn, when the tops die down, the roots may be lifted and clamped, but stecklings are often found to overwinter successfully in the seed bed. Protection against freezing is necessary, and towards Christmas a light covering of barley straw is usually strewn over the beds.

In spring,—February if possible, as soon as conditions are favourable, and the soil can be brought to a good tilth—the stecklings are dibbled out so that the crown of the root is level with the surface of the soil. The roots are planted twelve inches apart in rows 30 to 36 inches apart.

By July the crop is usually in full flower and from mid to late August the "kingheads" (primary umbels) begin to ripen their seed ; this is indicated by a definite browning. It is usual to go through the crop to cut these heads as they ripen. The main crop of heads i.e. secondary umbels, begins to ripen ten days to a fortnight later. The whole plant is then cut by hand a few inches from the ground with a seed hook ; the plants are gathered into small heaps and left to dry on the field but if the weather is unfavourable the crop is tied into bundles and stooked.

After two or three weeks drying the crop is carted, stacked, and thatched.

Threshing is done about Christmas time. Some growers use a clover huller to thresh carrot seed and remove the beard. With careful adjustment a huller will perform both operations, otherwise a special machine is necessary to remove the beard of the seed after threshing.

Alternatively to growing stecklings and transplanting, the crop may be drilled where it is to be grown. Then 2 to 3 lb of seed are required per acre, and the rows are drilled 30 inches apart.

For the production of stock seed, the seed is sown considerably earlier, i.e. early June ; this provides well-grown roots for transplanting and enables "off-type" roots to be discarded. The selected roots are usually clamped over winter, and planted in the following spring. An average yield is 7 cwt. to the acre.

Parsnip : Pastinaca sativa

The cultivated parsnip crosses with the wild type, so that this crop must only be grown in a district free of wild parsnip. Seed crops of different varieties of parsnip must also be isolated from one another.

Seed may be grown from stecklings, but it is more commonly produced from fully developed roots.

For stecklings, sowings are made in July and early August in seed beds, in rows 12 to 20 inches apart ; 0.5 lb. of seed on one twentieth of an acre should provide sufficient plants for one acre. For the production of fully formed roots earlier sowing is necessary.

Transplanting is done before new growth begins—usually in November, but sometimes in March ; the rows of plants are usually 2 to 3 feet apart, and the plants 15 to 24 inches apart in the row.

In early summer soil from between the rows may be turned up against the plants ; a ridging plough is commonly used for this purpose. The additional soil provides support for the plants, as they increase in height.

Harvesting begins in early August, at which time the plant and fruits are beginning to turn brown. The umbels tend to ripen at different times, and it is often the practice to remove them as they ripen. As time and labour do not always allow of such individual treatment, the whole plant may be cut with a seed hook when the majority of the umbels are ripe. The plants are tied in bundles and usually stood on end against the ridges in such a way that the seed is not in contact with

the soil. When thoroughly dry the plants are made into small conical stacks.

Threshing with a flail is sometimes recommended—this method will not result in such a large amount of broken stalks becoming mixed with the seed as in the case of machine threshing, and therefore reduces one difficulty in cleaning seed.

The caterpillar of the parsnip moth (*Depressaria heraclei*) sometimes attacks the crop. The caterpillars enclose themselves in a web, and feed on the flower clusters. An average yield is 8 cwt. per acre.

Parsley : Carum Petroselinum

Seed crops of different strains or varieties are always isolated. Sowings are made late in March or early in April, 4 to 5 lb. of seed producing sufficient plants for one acre. In August the plants are set out in the field, in rows 2 feet apart, and the plants 1 foot apart in the rows. The seed is harvested in late September in the following year, the plants being cut by hand, stooked and later stacked.

In some market garden districts sowings are made directly in the field in rows 1 foot apart. During August the foliage is cut close to the ground, bagged up, and despatched to factories for drying. Then every other row is ploughed out, the remaining rows being left to produce fresh foliage, throw up flowering shoots and produce seed in the following year. An average yield is 10 cwt. per acre.

Peas : Pisum sativum

Considerable areas of this are specially cultivated for seed. Sometimes, however, when the market prices of fresh green peas are too low to allow of picking, crops originally intended for this purpose are ripened and harvested for seed. Seed obtained in this way may not prove reliable as it does not receive the careful rogueing given to a crop intended primarily for seed.

Peas are commonly grown on heavy classes of soil, where drying out in periods of drought is less than on lighter soils. Clean land is essential for the crop does not compete effectively with weeds.

Sowings are made in spring as soon as the land is workable—in some parts of the Eastern counties as early as January or February ; the seed is drilled in rows 9 to 12 inches apart.

The rogueing of crops intended for seed needs to be careful and rigorous as there is a constant tendency for rogues to appear in all strains. About flowering time, and again later when pods are formed, the crop is inspected and all "tare leaved" plants and those not true to type removed.

Harvesting is done by hand, the haulms being cut with a hook, after which they are left in small heaps and turned from time to time to ensure quick drying, and thus avoid staining and damage to the seed by mildew. When partially dry the haulms may be built into cocks over tripods to complete the process. This is essential to avoid mildew developing in the stack.

Threshing is done with an ordinary threshing mill, but to avoid damage to the seed it is necessary to adjust the concave. After threshing the seed is cleaned, and finally hand-picked to remove discoloured and damaged seed.

Average yields are as follows (in cwt. per acre) :—Green peas, 8-10 ; Canning peas, 8-10 ; Drying peas, 15.

Beans : Vicia Faba, Phaseolus vulgaris, Phaseolus multiflorus

It is not the practice in England to provide for isolation of any of the bean crops grown for seed. In the case of French beans (*P. vulgaris*) this is understandable, for this crop is strictly self-pollinating. In the case of runner beans (*P. multiflorus*), however, it is at least surprising, for they are well-known to be cross-pollinated, while in *Vicia Faba* the 5-10 per cent of natural crossing which has been observed by breeders, undoubtedly leads to trouble.

Beans are threshed with an ordinary corn threshing mill, and provided the concave is set well away from the beaters, and the driving speed properly regulated, there is little danger of damaging the seed. After threshing the seed is hand-picked to remove damaged and discoloured seeds.

1. Broad Beans : Vicia Faba.

Broad beans are best suited to deep, well-drained loams ; adequate lime is essential.

In localities where the winter is not too severe, seed is sown in late October or early November, or, if in the spring, from January to March. It is sown in rows 18 to 27 inches apart, according to the vigour of the variety, with individual seeds four to six inches apart in the rows. Occasionally seed is sown in double rows 9 inches apart, allowing 2 feet 6 inches between each pair of rows.

When the lower flowers have formed pods the plants should be topped ; this checks the possible ravages of black fly, which usually commence their depredations around the growing point of the stem. The crop when ripe is treated exactly as a corn crop. An average yield is 12 to 15 cwt. per acre.

2. French or kidney beans : Phaseolus vulgaris.

Kidney beans, unlike broad beans, succeed best on light, sandy or gravelly loams. In the crop rotation, kidney beans follow potatoes, Brassicas, or roots that have been generously manured, but the crop also does well on freshly ploughed pasture.

Kidney beans are susceptible to frost damage

and at the same time require comparatively high temperatures to ensure uniform germination. Sowings are accordingly rarely made earlier than the first week in May. Seed is sown in rows 20 to 24 inches apart, and from 2 to 3 inches deep. A suitably adjusted drill is used, or the individual seeds are dropped by hand 6 to 8 inches apart. Double rows are sometimes preferred, when they are sown 1 foot apart and 2.5 feet between the pairs of rows. The usual rate of seeding is 60 to 80 lb. per acre.

In September as the plants begin to yellow the crop is pulled, handfuls of the plants are bunched together and stood upside down on the ground, so that the pods previously hidden by the foliage are exposed to sun and air. Drying may be completed by spreading the plants over hurdles tilted together or over tripods.

Sometimes the pods are gleaned as they ripen, the crop being gone over at intervals until it is cleared.

If stacking is necessary it is preferable to build the stacks under cover rather than in the open. An average yield is 10 cwt. per acre.

3. Runner Beans : Phaseolus multiflorus.

Runner beans like French beans do best on light, sandy loams, and it is usual to sow during the last few days of April and throughout May. One bushel of seed (60 lb.) is sufficient for an acre, but nearly double this quantity is often used. The seed is sown in rows 3 feet apart.

The plants are not usually staked but are allowed to ramble over the ground. For seed production the growing points are never " pinched out " as is the custom when the crop is grown as a fresh vegetable.

Failure to set seed is often a serious trouble, and may be due to low night temperatures during flowering, or to a serious lack of moisture, or to attacks of black fly.

Although undesirable from the point of view of producing well-formed, well-ripened seed, in practice two or three pickings of green beans are often pulled for marketing before the crop is left for seed.

The ripe beans are ready to harvest in late September, or in October or even later. The plants are cut off at ground level with a seed hook, and made into small heaps which are turned from time to time to assist drying. Finally, the partially dried material may be placed on tripods, each tripod being topped with rough straw thatch or covered with a sack. An average yield is 12 cwt. per acre.

The bean aphis (*Aphis fabae*) attacks beans of almost all kinds. As previously mentioned it is kept in check on broad beans by removing the tender growing points which first attract the pest. Any good contact insecticide provides a control, a nicotine spray being used for runner and French beans. Here the difficulty is to ensure that the spray reaches the aphides congregated on the undersides of the leaves. A mixture of $\frac{3}{4}$ oz. of 98 per cent nicotine with soft soap in 10 gallons of water is used.

As in sugar beet (q.v.), *Aphis fabae* on beans is also controlled by fumigation with nicotine vapour.

Onion : Allium Cepa

Two seasons are required for the production of onion seed ; in the first season bulbs are produced from stock seed, and in the second the plants flower and set seed.

Stock seed is sown from mid-February to March at the rate of 4 to 6 lb. per acre. The seedlings are lightly thinned, to about 1 inch apart, with the object of producing bulbs 1.5 to 3 inches in diameter. When mature, the bulbs are lifted and stored in airy conditions on trays, or, according to Bedfordshire practice, in specially constructed lofts with large doors and slatted floors and walls.

Since onions are cross-pollinated by insects, isolation between different varieties is usually provided, about 250 yards being the recommended minimum distance for commercial seed and one mile for stock seed. Onions do not cross with leeks. Bulbs are planted out either in November or in February and March. Overwintering in the land appears to stimulate running to seed, but on heavy land it may lead to the bulbs rotting. Before planting, the bulbs are " rogued " for undesirable types ; if planting is deferred to the spring, selection for keeping quality may also be made.

The bulbs are planted in single rows 24 to 30 inches apart or in double rows 12 inches apart with 30 to 36 inches between pairs of rows ; they are spaced 6 to 9 inches apart in the rows. According to the size of the bulbs and the spacing employed, 1.5 to 4 tons per acre are required.

The crop is kept free of weeds by hoeing, usually by hand, and when the seed stalks elongate they can be supported by string stretched between stakes.

The seed heads are ready to harvest when the earliest seed begins to shed. The seed coat is then black and the contents of the seed (endosperm) are doughy in consistency. The heads are cut by hand with 2-3 or 10-12 inches of stem according to the method of drying to be adopted. Several cuttings may be necessary as the heads ripen at different times.

Drying before threshing is the critical operation in onion seed production. In Bedfordshire growers use their onion lofts for drying the seed heads but any dry, well-ventilated glasshouse or shed is suitable. Heads cut with long stems are

tied in bundles and hung from wires; those cut with short stems are spread on trays, benches or floors. Whichever method is adopted it is essential to provide free movement of air to all the heads since those which are not in a direct current of air are liable to sprout or to go mouldy. As drying proceeds, the capsules open and the seed sheds; provision is therefore made to catch this seed on sheets. Finally the dry heads are threshed with flails or a small thresher and the seed winnowed. An average yield is about 3 cwt. per acre.

Leek : Allium Porrum

To obtain plants which will flower and set seed the following year, stock seed is sown in nursery beds in March or April in rows 18 inches apart. Sufficient plants for one acre are obtained from 2 lb. of seed.

The plants are set out at any time between June and October, 8 to 10 inches apart in rows 24 inches apart. The flower stalks develop in the early summer of the following year and at this stage the rows are often ridged to give some support to the plants. Later as the stalks elongate and the heads enlarge, further support may be given by tying the heads to wire or twine stretched between stakes or by bunching and tying the stalks of adjacent plants together.

Leek seed ripens very slowly and as it must be harvested about mid-October, to avoid frost damage, it is rarely fully mature. The seed coat will then be black and the consistency of the seed doughy. The heads are cut with a foot or more of stem adhering, tied in small bundles and hung on wires in airy barns or glasshouses. Unlike onions, the capsules do not open and very little seed is shed. Some growers complete the process of drying over the warm pipes of a greenhouse; the stems are then trimmed off and the heads put into bags which are hung above the pipes. The heads are threshed when they become brittle with drying. Unless fully dried the leathery texture of the capsules makes threshing difficult. The yields vary widely, but 2 cwt. per acre is a good average yield.

Lettuce : Lactuca sativa

Lettuce is an annual and since it is a self-pollinating plant isolation between different varieties is not required. Though frequently grown on a small scale, like onions and leek it is rarely grown on a large scale, because of its lateness in ripening seed.

The winter hardy varieties may be sown in early autumn, towards the end of August or the beginning of September, either in rows 18 inches apart, to be singled later, or in nursery beds to be planted the following spring. The non-hardy varieties are sown in spring, as early as can be considered safe, and are singled to 8 or 9 inches apart in the rows.

When the plants form heads the crop is rogued for early bolters and for off-types and the heads of the remaining plants are slashed in four to expose the bud. Between the first heading and running to seed is the danger period for rotting (*Botrytis* spp.), especially in wet weather; some control is afforded by stripping off the lower leaves and allowing plenty of air to reach all parts of the plant.

Flowering begins in the first half of August and seed forms towards the end of September, ripening being indicated by the appearance of white fluff. When 20 per cent of the flowers show this fluff the crop is ready to cut and, since seed is easily lost by being blown away or eaten by birds, it is better to cut early than late, especially as much immature seed is capable of ripening after cutting. The plants are cut close to the ground with a hook, allowed to wilt for a little time and then tied into bundles which are built into small stacks in the field, often with the bundles standing vertical. The stack is covered with a sack or a rough thatch. If moulds develop the stacks may be rebuilt, bringing the inside bundles to the outside. When the crop is thoroughly dry it is carted and stacked under cover until threshing. Yields are uncertain and variable; about 2 cwt. per acre may be considered average.

Tomato : Lycopersicon esculentum

The cultivation of tomatoes for seed is the same as for fruit production, as the seeds have to be extracted from the ripe fruits by pulping and fermentation. One ton of fruits produces from 5 to 15 lb. of seed. The more careful growers save seed only from plants of desirable types.

While the grower who is producing a small amount of seed for his own use usually pulps the whole fruits, those producing tomato seed on a large scale cut the fruits in two across the middle, squeeze out the seed and softer contents and retain the fleshy part in tubs of preservative, to be sent later to a factory for processing.

The pulp containing the seed is allowed to ferment for two or three days in wooden vessels, to remove the gelatinous coating of the seeds. Then the pulp is poured off through sieves and the seed is washed clean with water. If the seed is left too long in the fermenting liquid it quickly becomes discoloured and may lose germination. The washed seed is spread on cloths in a glasshouse to dry, some growers mixing it with dry sand or sawdust which is later separated by sieving.

References

1. National Institute of Agricultural Botany. Strains of mangolds. *Farmers' Leaflet* No. 6. pp. 4. (War-time edition). 1940.

2. National Institute of Agricultural Botany.
Strains of sugar beet. *Farmers' Leaflet* No. 5. pp. 4. (War-time edition). 1942.

3. Mercer, S. P.
Farm and garden seeds, with a section on the Seeds Act, 1920 by A. W. Monro.
London (Crosby Lockwood and Son, Ltd.) 1938 ; pp. 205.

4. Petherbridge, F. R., Jones, D. P. and Jones, F. G. W.
Investigations on sugar beet pests in England in 1940. Unpublished.

5. Scarfe, N. V.
The land of Britain—the report of the Land Utilisation Survey of Britain (Ed. L. Dudley Stamp) Part 82. Essex.
London, 1942. pp. 403-468.

Distribution and extent

The climate of Scotland is not sufficiently favourable to ensure that seeds of most of the common kinds of vegetables and root crops can be harvested in good condition each year. Thus, although the selection, breeding and trials of varieties are undertaken in Scotland, it is customary for seedsmen to have their stocks multiplied in more favourable climates. Seed production is practicable with small quantities of very élite stocks that are sufficiently valuable to justify higher costs and low yields, but stock seed that was sent to America, New Zealand, Hungary or the South of France before the present War produced crops of high quality seed at a cost much below anything possible in Scotland. An item of expense in Scottish production is the conditioning of home-grown seed in the warehouse, a practice unnecessary in the countries mentioned. Much of the stock seed of roots has been and is still being multiplied in the seed growing districts of England.

The first authentic record of seed production and supply as regards vegetable crops appears in Sir John Sinclair's Report on the Agricultural State of Scotland (1814); the following is a quotation from Volume 2, page 151. This statement may be said to describe the present situation rather accurately.

"Garden Seeds, etc.—It will easily be imagined, that on many of the culinary plants, the ripe seeds cannot be expected to be produced in Scotland. *Cabbage seeds, however, of all kinds ripen freely; likewise the seeds of German greens, green savoys, red greens, and Brussels sprouts; and in some places of broccoli.* The seeds of yellow turnip, early turnip, red topped, green topped, white Norfolk, glove, and yellow field turnips, are generally saved in Scotland. Many gardeners gather cress and parsley seeds for their own use. *The Scotch leek often ripens its seed*; and red beet generally does so. The seed of peas, beans, carrots, onions, lettuce, spinach, cauliflower, celery, endive, cucumbers, and others, are saved in the southern counties of England, and imported from London. When there is intercourse with Holland, Dutch onion and early turnip seed is preferred; and the seeds of all the sweet herbs are generally bought from that country."

It appears that the east coast and in particular the Coastal Belt of the Lothians, around Edinburgh and Musselburgh, has been long associated with the production of seeds. Several early districts in Fife have also produced such crops from time to time, but little seems to have been produced on the west coast, although in Ayrshire it has been possible to save certain cabbage seeds in perhaps four years out of six. Undoubtedly, the Spring cabbage now grown as McEwans Early has been grown for a very long time, and originally appeared to be known as Early Dwarf. So far as can be ascertained, it seems impossible to elucidate the historical significance of the name "McEwan" unless it was associated with the grower who developed it. Fifty years ago the same cabbage was known as "Vanack" or "Early McEwan." Another variety which has retained its name from the earliest records, and has been subjected to frequent re-selection, is "Early York", sometimes called "Battersea Early York."

Another old variety of vegetable that has originated in the market gardening district of the Lothians is the Musselburgh leek.

At one time, the seed of Swede turnip was grown on a fair scale in East Lothian, while in Lanarkshire one farmer grew a special variety of swede for 40 years, sowing 5 acres per annum. In the Musselburgh district, the area of brassicas grown each year varies from 5 to 10 acres; in 1942, there were from 15 to 20 acres. While climatic conditions may spoil a crop completely, a fair crop may be expected in five years out of six.

In parts of Aberdeenshire it is customary for farmers to select and produce seed from turnips and swedes for their own requirements. Though the actual quantity of seed produced in this way is probably negligible, it is of importance as a potential source of new varieties. Strains that have been grown continuously on the same farms for a hundred years or more can be regarded as highly attuned to their environment. The "Bruce" turnip, which shows outstanding resistance to finger-and-toe disease, was obtained from a strain grown on two or three farms where the disease has long been prevalent (Findlay, W. M. "A Disease-resisting Turnip," *Scot. J. Agric.* 14. 173-83. 1931).

A considerable proportion of the swede and turnip varieties of Great Britain are the products of Scottish seedsmen, or are bred for the Scottish market. The selection of mother plants, and the raising of stock-seed from them is conducted in the chief root-growing areas of Scotland, but the multiplication of the stock-seed is transferred to England, and many Scottish seedsmen have their own seeds farms in Essex.

Field technique : Brassicas

Cultivation. As all the brassicas are

*Based upon two memoranda, received from W. Robb, Corstorphine, and Robert L. Scarlett, Sweethope, Midlothian.

biennials, cultivation is on similar lines. The fundamental principle is to plan so far ahead as to provide for the necessary isolation of crops and an area sufficient to yield supplies to carry forward for at least two years. Because of this vitally necessary long-term policy, it was impossible to "create" the quantities found necessary for wartime requirements for at least two years after the necessity arose.

Whatever brassica seed crop is to be grown, the vegetative crop is selected during the first autumn. Usually the heads are cut and sold, as otherwise they would rot. The root or "runt" from which the seed crop grows is left in the land over winter. The lower "sprouts" only are removed from a proposed seed crop of that vegetable. Sometimes the "heads" of savoy and greens are left too. Occasionally, when a small lot only is desired the "runts" of selected plants are lifted and transplanted in late autumn to a position far enough removed from other seed crops to prevent cross pollination.

During winter the seed crop is carefully cleaned; in fact, the area is usually dug over to remove any perennial weeds that may be present, as little or no cultivation is possible when growth begins in Spring.

The seeding stems are very easily broken by wind or shakings from implements.

By July or early August the seeds in the pods become slightly coloured, linnets become very numerous and the crop is detached from the parent "runt" by breaking or cutting the stem, tying into bundles and stooking in the field. At this stage a warm rain can ruin half the yield, since the pods open up very easily. Usually the stooks stand out 10 to 14 days; the crop is then stacked, using plenty of crates, flakes, etc. to admit air freely. Thatching is done the same day.

Field technique. Swede turnip

SWEDES. Selection is carried out in late autumn on well-grown crops of the desired variety. Plants conforming with the ideal type and free from blemish or disease are chosen and carted to a field where they are to be seeded during the following year in natural isolation. They are planted up to the neck in the soil by setting them in the furrow and ploughing them in. The stock seed so obtained is usually not mature early enough to send South for multiplication in the year it is harvested, so seedsmen hold stocks of seed which they multiply in England as and when required.

An experienced Scottish seed grower outlines the methods followed by his firm: "In selecting roots for Stock Seed a certain amount of environmental selection takes place almost automatically. My firm, for instance, selects its own three kinds of swedes, an early crop, a main crop and a hard late keeper. I find that the early does best on the lower and lighter lands, the late keeper on the clays or higher districts and the main crop intermediate. When it comes to bulb selection strains are generally found to be most suitable in the district or type of land from which their stock seed was selected and when a new customer for turnip seed comes along we not only consider the use he is to make of his swede crop, but also the land and elevation of the farm, when deciding the variety of swede to give him; hence our varieties have gradually become suitable for both varying time of use and specific types of land or district. The earlier varieties of Yellow turnip can be selected from low early districts but we find it best to select our late-keeping yellow turnips from higher or late districts."

Harvesting. Turnip requires special care in harvesting since it "sheds" or drops so easily. Ripening is rapid and the crop demands a visit every few hours to judge the proper time for harvesting. In fact each variety has points requiring special care at each stage which demand immediate attention and action. A most important point is to avoid the inclusion of small particles of soil or of weed seeds with the crop. This is all too easily done and they are most difficult to remove when cleaning the seed afterwards.

Threshing in Scotland is rarely possible at the stage when carting to the stacks is undertaken. A period of 12 to 16 weeks in stack seems essential for the production of seed which will keep well and retain a high germination strength. Various methods of threshing are used. When small quantities are grown, beating out by stick or flail is still practised. Small threshers are very useful. The old fashioned Scotch mill with slow-speed beater drum is probably the best means. Occasionally the ordinary corn threshing mill is used, but is economical only when a quantity of 10 to 20 cwt. is to be threshed.

Carrot and leek seed may after adequate drying be rubbed through $\frac{1}{8}$ in. riddles by girls. After winnowing and fannering, the seed is finally cleaned by hand sieving, an operation of some skill. In all threshing and cleaning operations, the greatest care is always necessary since brassica seeds of different kinds cannot be distinguished.

Special problems

Heavy rainstorms in summer frequently wash away so much pollen that fertilization does not take place. Attacks by insects may also cause sterility. A wet summer means a very low percentage of fertile seeds of leek. Early leeks take longer to ripen seed.

HARDINESS is recognized as the special virtue of all Scottish-grown seeds. The usual practice with brassicas is to sow in August. The plants stand over winter in the seed beds and are transplanted in spring to provide a longer season of

growth than is obtainable by spring sowing. It has been proved so frequently as to be recognized as conclusive that seeds derived from spring-sown plants are so prone to produce bolters that these are not used at all for seed crops. July sowings of McEwan cabbage especially and all new introductions are tried out on a very small scale to obtain reliable information on this important matter. The tendency to bolt is gradually eliminated by selection.

Varieties and relative merit

This could occupy a great deal of space and time, since so many factors influence a grower in making a selection. Certain selections stand up to wind and frost much better than others. One type of leek with fewer roots may suit certain land for a limited period of marketing, while later in the season such a variety may melt away under increasingly severe weather conditions. There is much more in the acclimatization of selections than appears at first sight. Especially early and late varieties of broccoli formerly much prized have been lost because of the long period of very low prices for this crop. Some of these were so well protected by leaves that they looked like a very firm cabbage and the curd was past its best when the cabbage-like heart burst. When the Roscoff broccolis first came north, they produced good crops and seeded profusely but these excellent strains have also been lost. The most hardy winter brassicas produced by market gardeners are never sold but are utilized to produce crops. The seeds are saved in small quantities only. The chief reason why fewer hardy plants of winter stuff are to be found in allotments is that small growers plant out at *one season* only and do not reserve ground for later plantings to provide the later crops for use in spring and early summer.

Varieties Usually Grown.

Cabbage : Early Large York, Winnigstadt, McEwan's Early or Vanack (in many selections), Late Drumhead or Ox, and Red Pickling.

Savoy : Dublin Cape, Ormskirk Late (in selections).

Brussels Sprouts : in several varieties including Dalkeith, Darlington, Solidity, and Garleton.

Curled Greens, Leeks : Chiefly Musselburgh and some early varieties with local reputation.

Turnip : Early Milan, Golden Ball and Swedes.

Carrot : small quantities in variety.

Beet : Long beet only, since rounds are easily thrown out by frost.

Spinach Beet.

Broccoli : in small quantities.

Research at Corstorphine

The constitution of the Scottish Society for Research in Plant Breeding provides that its Station may undertake work with horticultural crops, but prior to the War this side was not developed. Root-crop investigations have been mainly concerned with the swede though other brassicas have been dealt with on a small scale. Vegetable-seed growing has now been undertaken as a war-time measure. A crop of heading broccoli was successfully grown, culled and seeded, yielding a good quality of seed in excellent condition. Success has also been achieved in the production of carrot seed for two years, but there are indications that the rapid increase of carrot fly will make it impossible to grow this crop continuously at the Station. Dwarf peas have yielded moderately well, but the season is too short for haricot and dwarf beans. Dwarf beans have not been grown but the agricultural Tick Bean is normally harvested in good condition. Cress when grown for seed was found to be severely attacked by a root-fly, but a reasonable amount of seed was secured. Leeks have been seeded with uncertain results ; wet-weather conditions while the seed is setting would appear to constitute a grave risk in this district. Conditions also seem to be unfavourable for the seeding of onions.

Need for Hardier Strains of Winter Brassicas. It is noticeable that Scottish gardens and allotments do not on the whole produce the quantity and variety of brassicas for use in spring that might be desired. One reason for this would appear to be that many of the varieties of Savoy cabbage and broccoli offered are not sufficiently hardy for northern conditions. Variety trials have been carried out at the Station and by the Edinburgh and East of Scotland College of Agriculture at Cupar and other places in Fife, and it has been found that there are great differences in the winter hardiness of the varieties (Lang, J. M. S. "A Trial of Broccoli Varieties in Scotland." *Scot. J. Agric.* January, 1943.) Experiments have been commenced at the Station to attempt to breed hardier strains of broccoli from the best of the present varieties.

Experiments with Swede Turnips. Inbreeding by enforced self-fertilization has been practised with swedes for ten generations at the Scottish Plant Breeding Station. The swede is unique among root crops in being fully capable of self-fertilization and the effects of inbreeding are not markedly detrimental. Lines can be bred which possess a high degree of uniformity, and it seems possible that a mixture of a few such lines might form a useful basis for reconditioning a variety which had become too variable or contaminated under mass-selection. The method has not yet given any strains sufficiently distinct and valuable to be considered as new varieties. Dry-matter tests in conjunction with yield have been employed at the Station to check the feeding value of lines.

Organization and legislation

There are no official or other seed-growing organizations in Scotland, the growing of seed being generally organized by the Seed Trade. There are no certification schemes. Some form of legislation may be necessary to prohibit small cottage gardeners from allowing a few stray plants to go to seed and contaminate an adjoining field crop.

Under present conditions it has not been found possible to give an entirely up-to-date account of the important industry of vegetable seed production in Holland.

We are assured, however, by Mr. B. Gerritzen, Agricultural Attaché to the Netherlands Embassy, London, that the essentials of such production are contained in a bulletin by J. Leendertz issued by the Dutch Ministry of Agriculture in 1920 entitled Rapport betreffende de Zaadteelt, pp. 72.

A slightly abridged translation is available for consultation at the Bureau at East Malling.

The following notes, with an addendum by Mr. Gerritzen, are taken from it :—

The author deals briefly with the history of seed production in Holland, noting the immediate effects of the last war which included in the first place a reduction in the growth of a number of crops and, secondly, the introduction, or at least the intensification, of the production of certain seed under glass, especially in East Groningen, the crops concerned being, initially, purslane and summer cauliflower.

The chief seed growing areas in Holland are Noordholland, Groningen and Zuidholland and the most important seed crops spinach, radish and brussels sprouts. The production of cauliflower seed under glass increased greatly in the period 1914-1918.

Factors which were found to affect the area under seed cultivation included prices, extension of vegetable growing, change in cultivation methods, flooding by sea water, Government restrictions.

The arrangements under which the different vegetables for seed are grown in Holland differ greatly. They are :—1. Production for own use. 2. Production by contract whereby the seed merchant provides seed or planting material, (a) the crop being delivered to the seed merchant, cleaned or not, at a prearranged price or (b) the delivery price being settled later by the seed merchant in relation to the market price in consultation with representatives of the grower. 3. Production by the seed merchant himself, (a) on his own ground, (b) on rented ground. 4. Free production, the grower marketing his own seed.

The growers have evolved various measures to prevent degeneration of stock due to cross pollination. Thus the growers of Broek op Langendijk reached an agreement which should effectively guarantee the purity of their cabbage strain. The land round the town was divided into 8 sections and in each section in a given year only one particular strain might be grown by the different growers. Moreover it was laid down that land thus planted should be surrounded with a boundary strip 200 metres wide on which no seed plants were allowed to be grown.

Seed merchants guard against deterioration by allowing each of their contract growers to grow only one particular strain.

Various associations have their particular methods for ensuring purity.

One of the more prominent of these was that founded by the Groningen seed growers in 1918. Apart from various measures for co-operative buying and selling the association saw to inspection of the plants in the field, control of harvest and delivery of seed to a central packing house. Severe penalties were exacted from members for sharp practice and no member could grow more than one variety without the knowledge of the administration.

Note by Mr. B. Gerritzen.

The above society was later wound up.

Results of these and other efforts to procure a more satisfactory degree of control were not entirely up to expectations. Hence in 1935 the N.A.K. (General Netherland Inspection Service)—a central body which directed the Inspection Services for agricultural and horticultural crops grown for seed and incidentally controlled such horticultural material as fruit tree rootstocks and scions—undertook the organization of the proper control of vegetable seeds in order to supply market gardeners with better guarantees as to origin and purity, freedom from diseases carried by seeds, germination capacity and utility value of the seeds they use. General rules and regulations were drawn up for that purpose. Although the Seed Trade did not co-operate so fully as had been hoped, progress was made and the inspection service developed.

Before the present war the Horticultural Section of the N.A.K. had started research work on varieties in their experimental garden for vegetable seeds at Wageningen and a special research worker on diseases carried by seeds was attached to the Laboratory for Mycology and Potato Research at Wageningen, vegetables being his chief concern.

Initially, only self-pollinators were inspected but gradually also cross-pollinating plants were controlled and special measures were taken with regard to farms where selection work was carried on, the responsibility of the farm managers being strongly emphasized.

It cannot be denied that gaps still exist in the technical measures on which control is based.

It also should be recorded that a course was established in 1939 for the training of inspectors of vegetable crops in the field intended for seed, and of propagating material used in other branches of horticulture. Nine diplomas have so far been awarded.

In the year 1st July, 1938—30th June, 1939, 169.175 hectares of beans (*Phaseolus* and *Vicia* spp.) were inspected as well as 186.23 ares of brassica and 1651.87 ares of other vegetable seeds. The total area under garden seeds in 1934 was 1303 hectares.

The importance of freedom from disease is now better appreciated than it was some years ago. It has been found, e.g. with dwarf French beans, that :

a. in several localities danger of infection with mosaic is larger than in others,

b. late sowing promotes the danger of infection,

c. in localities with a small risk of infection and early sowing, it is important to use virus-free seed,

d. in localities with a great risk of infection and when sowing late in the season, virus-free seed is no guarantee of a healthy plant.

Needless to say, aphis is the main cause of infection, but control of this pest does not prevent mosaic, as spraying is not usually started before the aphis has been noticed.

The Horticultural Section of the N.A.K. is directed by a Board with 12 members and 5 advisory members. Several Committees for special subjects have been constituted, but so far none for vegetable seeds.

The advisory members were :

Prof. A. M. Sprenger, Director of the Laboratory for Horticultural Botany. Dr. W. J. Franck, Director of the Government Seed Testing Station. Mr. N. van Poeteren, Controller, Chief of the Plant Pathological Service. Mr. P. Hus, Plant Pathologist of the Plant Pathological Service. Mr. J. Siebinga, Secretary to the General Netherlands Inspection Service.

Brief notes are given of experimental work [prior to 1918], chiefly on manuring and selection. Crops subjected to manurial experiments have included corn salad, spinach, beet, root crops and onions. Those on which selection and breeding work is reported are cauliflower, purslane, chicory, beet, runner beans, green peas, lettuce.

Cultural methods

The methods of harvesting differ greatly and plants may be divided as follows :—

1. Plants, the seed of which is gathered as soon as ripe from plants which have not dried off, several pickings being necessary.
2. Plants, the seed of which is harvested after the whole plant or the above ground parts are dead.
   (a) The ripe seed falls and after the removal of the dead plant, debris is collected by sweeping and cleaned by sieving, e.g. corn salad.
   (b) The seed stays on the dead stems and is cut or picked off.
      (i) Seed can be separated from the dead parts immediately after harvesting, e.g. parsnip.
      (ii) The plant parts with seed attached are left to weather on the ground after cutting, e.g. for a short time cabbage, for a longer time radish, endive.
3. Plants, the seed of which is gathered more or less unripe, the ripening being continued by artificial drying methods, e.g. leek.

Diseases which endanger the crop, to mention but a few, are celery leaf spot (*Septoria apii*), anthracnose of bean (*Colletotrichum lindemuthianum*).

Combined plantings are frequently seen including the following arrangements :—

1. Successional planting, e.g. spinach or cabbage lettuce [presumably as a vegetable crop] followed by gherkins for seed.
2. Interplanting, e.g. endive for seed between early lettuce for the vegetable market or alternate rows of lettuce for seed and lettuce for market.
3. Successional planting, e.g. turnip or turnip rape for seed followed by celery for seed.
4. Undercropping, e.g. spinach seed with caraway seed.

Directions are given for sowing, growing and harvesting the seed of the following plants:—

Beans (various), beet, broccoli, Brussels sprouts, cabbage, carrots, cauliflowers, celery and celeriac, chervil, chicory, corn salad, garden cress, cucumber, dill, endive, fennel, gherkin, kale, kohlrabi, leek, lettuce, marrow, onion, parsley, parsnip, peas, purslane, radish, salsify (black), scorzonera, spinach, swede, turnip, winter radish.

SWEDEN

ROOT CROPS AND VEGETABLES

The Swedish firm of publishers, Nordisk Rotogravyr, in their series of books on numerous aspects of agricultural production in Sweden, have published two important books on the production of seed.* One deals chiefly with herbage plants, root crops, and to a less extent with vegetables; the other entirely with vegetables.

It is hoped that permission may be obtained by the Bureaux concerned for the publication of abridged translations of these two works. At the moment, it is possible only to give extracts which indicate the general development and control of the production of seed of root crops and vegetables, and to leave the agronomic details of actual production methods for subsequent publications. Before dealing with these general aspects, it should be noted that the following vegetable crops are grown for seed in Sweden with a reasonable degree of success: beans (various), garden beet, brussels sprouts, carrot, celeriac, celery, chives, garden cress, cucumber, drumhead cabbage, kale, lettuce (greenhouse varieties), parsley and large rooted parsley, parsnips, peas, radishes and black radishes, scorzonera, sorrel, spinach, swedes, turnips and tomatoes.

Seeds of agricultural crops have been produced in Sweden since the 17th or 18th centuries; the seeds of flax, turnips and swedes must have been largely home-produced, although probably on a small scale. The production of seed of root crops was extended considerably during the 19th century, more particularly in the period from 1880 to 1900, an advance due largely to the initiative of Walfrid Weibull; the amount produced, however, still fell far short of the country's requirements, and most of the seed had to be imported, even into the 20th century.

The year 1910 is regarded as a turning point in the history of Swedish seed production. It was then that seed growers' associations were revived or established in all parts of the country, and in 1914 the Union of Swedish Seed Growers was formed. With the plant breeding stations and the large seed firms at the head, the production of seed of numerous herbage plants and fodder and sugar beet was extended considerably; seeds of these plants had formerly been produced only on a small scale, if at all.

After the First World War, a large quantity of foreign seed of very doubtful value was dumped on the Swedish market, more particularly in the case of root crops and vegetables. The prohibition of the importation of seed of herbage plants, root crops and vegetables introduced in 1921 proved helpful to Swedish production, although there was a reduction in the early nineteen-twenties. By 1925, however, the area under seed production in Scania had reached 1,500 ha., and has since increased gradually. Difficulties arose again later through over-production, particularly in Denmark, and the low world market prices generally. Since 1933, the Ministry of Agriculture has greatly restricted the issue of licences for the importation of seed of root crops.

Again in 1939, the Ministry strengthened the regulations regarding the issue of licences for the importation of vegetable seed which may be produced in Sweden. In the case of annual crops, such as spinach, radish, dill and cucumber, it was stipulated that permission to import during 1939-40 should be granted only to those importers who could prove that they met at least one-third of their requirements with Swedish seed. The same quota was to apply to biennials (carrots, red beet, swede turnips, parsnips and parsley) during the season 1940-41 and onwards. It was estimated that after two years of transition the country would be self-supporting in vegetable seeds and that then permission to import would be granted only in exceptional circumstances.

The figures quoted in Tables 1, 2 and 3 show the extent to which Sweden may expect to meet her own needs as regards seed of root crops and vegetables.

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* HERTZMAN, Nils, NILSSON-LEISSNER, G., SCHWANBOM, Nils, and ARONSON, Linder. Lantbrukets fröodling. [Agricultural seed production.] Published by Nordisk Rotogravyr, Stockholm, 1940. 19 x 13. pp. 285.

NILSSON, Ernst. Köksväxtfröodling. [Seed production of vegetables]. Published by Nordisk Rotogravyr, Stockholm, 1940. pp. 160.

Table 1.—Average yield of seed of root crops in Scania and Denmark during recent years (in tons).

Species	Scania				Denmark
	1920/1924	1925/1929	1930/1934	1920/1934	1926/1933
Mangold, Barres	1,440	1,851	2,312	1,900	1,490
Mangold, Eckendorfer	1,364	1,304	1,767	1,508	—
Sugar beet	1,638	1,911	2,407	1,988	—
Swedes	1,603	1,634	1,613	1,619	1,050
Turnips	1,275	1,407	1,434	1,396	800

Table 2.—Requirements, domestic production, import and export (in tons) at present day, of seed of root crops.

Species.	Annual requirements	Domestic production	Import	Export
Sugar beet	1,300	1,300	—	—
Fodder sugar beet	75	75	—	—
Mangold, Barres	400	500	—	—
Mangold, Eckendorfer	125	30	—	—
Swedes	200	250	—	—
Turnips	150–200	200	—	—

Table 3.—Sweden's requirements of vegetable seed (in kg.)

Broad beans	45,000
Dwarf (field) beans	45,000
Dill	16,000
Cucumber	16,000
Cauliflower	1,100
Brussels sprouts	600
Onion, all kinds	16,000
Carrot, all kinds	40,000
Parsnip	9,000
Parsley	8,000
Radish	24,000
Red beet (*Beta vulgaris*)	40,000
Lettuce	3,000
Spinach	70,000
Sugar-pea	54,000
Green field-pea	30,000
Marrowfat pea	156,000

In addition to variations in climate which occur between southern and northern parts of the country there are even greater differences between places situated near the coast and those further inland. The risk of severe night frosts in spring and autumn is not so great near the coast. This is of importance not only for overwintering steckling plots of swedes, turnips, carrots, etc., but also for planting out of beet stecklings and certain vegetable crops in the spring. These should be planted out as early as possible, but are readily injured by severe night frosts. During unfavourable years, when seed of beet, carrots, etc., ripen late, night frosts in autumn can also cause considerable damage.

Seed production of roots, commercial plants and vegetables has up to the present been almost entirely concentrated in the coastal districts of Scania, as climate and soil conditions have proved to be most favourable there. A few plots of the kinds of plants mentioned are found also in other places in the most southerly parts of the country, but the majority occur in a strip approximately 20 km. wide along the Scanian coast from Kullaberg to Simrishamn. Seed production of turnips, swedes, carrots, marrow stem kale and vegetables is practised as a rule on the lighter soils nearest the coast, while beet and some commercial plants are frequently grown a little further away from the sea and on somewhat heavier soils.

During years when the weather during the growing period is cold and wet it may happen that the seed of beet, carrots and certain vegetables does not ripen until late in the autumn, that night frosts impair viability and that when cutting is carried out very late the weather is most frequently unfavourable for harvesting. The over-wintering seed plants of swedes, turnips, marrow stem kale, etc. are very dependent on climate. During severe winters, and particularly during winters with frequent and great variations in temperature, it often happens that the seed plants are completely destroyed and that the field has to be ploughed up in the spring.

On a light clay soil containing humus practically all kinds of seed can be grown, more especially beet, swedes, turnips, cabbage, mustard, spinach, etc. Heavy clay soils are not so suitable but good crops of seed of beet and cabbage can be obtained. Turnips, carrots and spinach thrive on sandy soil.

As a general rule, the soil most suitable for seed production is humus-rich, clay, or sandy soil. The soil layer should be deep. The nature of the

subsoil is of great importance, principally because it influences the water supply of the plants, but also because the plants derive a part of their nutriment from it. A subsoil of calcareous clay or marl is best. It is of great importance that the soil should be well drained.

State sealing of seed was begun in Sweden 50 years ago. Originally it consisted in the Seed Testing Institute being obliged, if so required, to take samples of a lot intended for such sealing, and if the seed satisfied the requirements prescribed by the Ministry of Agriculture, to furnish each parcel of the lot with a certificate as to its quality. Such sealing provides only a guarantee of such properties as germination, purity, etc., but not of genuineness of variety or strain. After the establishment of the State Central Seed Testing Station in 1925, State sealing has been much developed and different forms of it have been introduced. Ordinary State sealing is still certainly retained, although the standards for germination, purity, weed content, etc., are now much higher, but in addition it carries with it a certain guarantee of genuineness of type or genuineness of variety in that on the certificate of sealing must be set down, in the case of red clover, the type (late, medium-late or early) and in the case of seed of root crops the variety. The correctness of this is controlled by the State Central Seed Testing Station by means of after-control cultivation of samples taken on State-sealing, and the purchaser can, by sending in the certificate of sealing, obtain information concerning the results of the controlled cultivation; by this means, if wrong information has been given as to type or variety the purchaser is enabled to assert his claim to compensation. A somewhat stricter form of State sealing, which applies more particularly to herbage plants, is that of *superior quality seed*. The highest forms of State sealing are those with *control cultivation* and original certificate, both of which in the main involve the same control measures and can be carried out only by the State Central Seed Testing Station. These forms of State-sealing give the most reliable guarantee possible of genuineness of variety, or genuineness of variety and strain, so that only seed sealed in such a way should be used for sowing.

The procedure in sealing with control cultivation certificate is briefly as follows. A grower who wishes to participate in control cultivation has in good time before sowing to notify the State Central Seed Testing Station, which will have a sample taken of the seed intended for seed production. The sample is sown on the control field of the Station (pre-control cultivation) and this plot will be subjected to examination during one or in the case of perennial plants during two growing periods. If there is no criticism of the pre-control plot as regards genuineness of variety and strain, field inspection is carried out at the grower's farm to determine, first, the agreement of the plot with the pre-cultivation plot and second, its isolation in relation to other cultivations, etc., which might involve the danger of crossing. Field inspection of seed plots of root crops is carried out twice, first, during the autumn of the year of laying down of the steckling plot, and second, during the following year. If there is also no criticism of the seed plot during the field inspection, the Station takes samples of the harvested and ready cleaned seed and these are tested in the laboratory; if they satisfy the requirements for State sealing as quality seed the final sealing is carried out with two certificates, one a control cultivation certificate showing the results of pre-control cultivation and field inspection, and the other a quality certificate regarding germination, purity, weed content, moisture content, etc. Finally, a sample of the sealed seed is sown in the way previously described for *after-control cultivation*, which is necessary, as if care has not been taken admixtures may have been introduced during carrying, storage in the barn, cleaning and so on. This form of control with pre-control cultivation, field inspection, laboratory examination and after-control cultivation undoubtedly constitutes as thorough a control of genuineness of variety and strain of a parcel of seed as can possibly be procured.

In addition to the State Seed Testing Station, local State-aided seed control stations carry out both ordinary and quality sealing. Sealing as original seed as well as with control cultivation certificate is done only by the State Seed Testing Station.

Seed production of root crops has for a long time been concentrated in Scania: the number of seed plots there has grown considerably in recent years with the result that the risk of crossing between different plots has increased. An exact knowledge of the distance required to prevent crossing between these plants is therefore now more necessary. On account of this increase in the number of seed plots of root crops, the Scanian Seed Growers' Association a few years ago arranged for an investigation to ascertain what measures should be taken to prevent crossing between different seed plots. The result was that the General Swedish Seed Co., W. Weibull & Co., Carl Engström & Co., Otto J. Olson & Son, together with the Swedish Sugar Manufacturing Co., Ltd., pledged themselves to issue to all their contract growers of seed of root crops certain regulations concerning measures to avoid crossing. Contract growers of the firms mentioned are all bound by the regulations, and they constitute the majority of growers of root crop seed. The Seed Growers' Association has also arranged that "free" growers of seed are bound by the regulations in so far as their plots cannot be passed on inspection unless they are situated at a certain fixed distance from other plots.

Table 4.—Requirements for ordinary State sealing. Root crops and vegetables.

Species	*Purity per cent (max.)*	*Maximum no. of weeds seeds per kg.*		*Germination per cent (min.)*	*Moisture content (max.)*
		noxious	*all*		
Root crops					
Mangold, Swedish	97	50	300	77	16
Mangold, foreign	97	50	300	82	16
Beet, sugar, Swedish	98	50	300	77	16
Beet, sugar, foreign	98	50	300	82	16
Swedes, Swedish	98	100	1,000	85	12
Swedes, foreign	98	100	1,000	90	12
Carrots, Swedish	93	200	4,000	65	15
Carrots, foreign	93	200	4,000	70	15
Turnips, Swedish	97	100	1,000	87	12
Turnips, foreign	97	100	1,000	92	12
Vegetables					
Beet, red, Swedish	98	—	—	75	—
Beet, red, foreign	98	—	—	80	—
Broad beans	99	—	—	90	—
Dwarf field beans	99	—	—	87	—
Pole beans	99	—	—	87	—
Dill	95	—	—	65	—
Cucumber	99	—	—	90	—
Cabbage, all kinds	98	—	—	80	—
Parsnips	90		—	75	—
Parsley	95	—	—	65	—
Radish	97	—	—	80	—
Spinach	97	—	—	75	—
Lettuce	98	—	—	85	—
Sugar peas	99	—	—	85	—
Green field peas	99	—	—	90	—
Marrowfat peas	99	—	—	85	—

Table 5.—Risk of crossing with other plant species

In seed production of the following species	*there is a risk of crossing with the species mentioned below*	
	great	*less serious*
Root crops		
Sugar beet	Fodder sugar beet, mangold, red beet	Sea beet
Fodder sugar beet	Sugar beet, mangold, red beet	,,
Mangold	Sugar beet, fodder sugar beet, red beet	,,
Swedes	Turnips, *Brassica napus oleifera*, *B. Rapa oleifera*, field cabbage	Marrow stem kale
Turnips	Swedes, *Brassica napus oleifera*, *B. Rapa oleifera*	Field cabbage
Carrots	Wild carrot	—
Vegetables		
Dwarf field beans	— — —	Horse beans, broad beans
Broad beans	— — —	Dwarf field beans, horse beans
Drumhead cabbage	Brussels sprouts, kale, marrow stem kale,	Cauliflower, field cabbage
Kale	Brussels sprouts, cauliflowers, drumhead cabbage, marrow stem kale, field cabbage	
Brussels sprouts	Drumhead cabbage, kale, field cabbage	Cauliflower, marrow stem kale
Red beet	Sugar beet, fodder sugar beet, mangold	Sea beet
Carrots	Wild carrot	— — —
Parsnips	— — —	Wild parsnips
Radish	Black (turnip) radish, *Raphanus raphanistrum*	— — —
Parsley	Large rooted parsley	
Large rooted parsley	Parsley	— — —

Growers of seed of root crops must also keep a sharp look out for bolters in neighbouring beet fields in beet seed production, for field-cabbage in turnip and swede seed plots, and for wild carrot in carrot seed plots.

With seed of turnips and swedes it frequently happens that during inspection of the stecklings in the autumn, plots are found with different plant types, varieties and strains, which is due to the plots having been laid down too near each other. In some cases considerable admixtures of turnips have been found in swede stecklings, due to the fact that turnip seed had been grown on the farm previously. Again it is common on inspection immediately before or at the beginning of the flowering period to find a large number of seed plants of swedes in spring corn fields bordering on seed plots of turnips or swedes. On these spring corn fields, swedes had been grown for fodder the previous year and in harvesting this crop some small roots and stecklings are always left in the ground; in the autumn these are ploughed in and the following year grow up into seed-bearing plants.

It is recommended that root crop seed plots should be subjected to at least two field inspections. The first should be carried out in the autumn, when the roots produced during the first cultivation year (the stecklings) should be carefully examined as to genuineness of species, variety and strain. In different parts of the field random samples are taken in such a way that at each place at least 50 roots are pulled up and examined. On the occasion of this inspection, isolation is also controlled. With beet, the grower before planting out the following spring should ascertain if any of his neighbours intend growing beet seed, and if so should come to an agreement with them as to the prescribed minimum distance between the plots. In the case of other root crops of which the stecklings overwinter in the place of growth, isolation should be controlled during this inspection; if this is not adequate and the cultivation for this reason has to be discarded, the loss to the grower will be considerably less if the plot is ploughed up so that the field in the following spring can be sown with another crop, than if this work has not been carried out before the inspection during the second cultivation year. Further, one should make sure that a seed plot of stecklings which overwinter in the place of growth is not laid out on ground where during recent years seed production has been carried out of another root crop variety or of a crop which through shedding of seed or as a result of portions of roots remaining in the soil can constitute a risk of admixture or crossing.

The second field inspection of seed of root crops is carried out at the beginning of flowering during the second cultivation year. In doing this, care must be taken to see that there are in the plot no hybrids or plants of a perceptibly different species or variety and also that bolters and other seed plants on the grower's own plot as well as those of his neighbours of such root crop plants as can involve a risk of crossing and which are located within 600 metres distance from the plot, are removed before flowering. In addition one must make sure that in the field or its immediate neighbourhood there are no wild plants with which crossing is possible. It is also of importance that the field should be free from noxious weeds, for example, charlock in turnip and swede seed. Finally, isolation should also be investigated during this inspection.

As already stated *State-sealing with control cultivation certificate* is a very satisfactory form of control. Ordinary State sealing has been carried out for 50 years; it consists in the Seed Testing Station, after notification has been made, being responsible for taking samples for sealing of the particular lot of seed; if the seed when tested is found to fulfil the prescribed requirements, each sack is furnished with a State seal. The requirements for State sealing have in the course of time been made more rigorous and there are now the different kinds of State sealing described above.

As State sealing cannot be carried out with vegetable seed, which most frequently is sold in small packets, the State Central Seed Testing Station has introduced a special form of control: staining with chemical solutions. In this form of control, seed is received only of those strains of vegetables which after two years of test cultivations in so-called classifying strain trials in State gardens have been pronounced first class or first class élite strains. To obtain this distinction the strain has to fulfil very exacting requirements as to yield, quality, etc.

A grower who, as a result of testing, has had a strain approved as a "first-class strain" has the right to participate in the control in question. A sample must be sent within the prescribed time to the State Central Seed Testing Station of the stock seed of which the commercial multiplication seed is to be stained with a chemical solution. Pre-control cultivation is carried out with the sample of stock seed, and if the strain then proves to conform exactly to that which was tested in the strain trials, the parcel of multiplication seed is stained, provided that in the laboratory test it fulfils the requirements as to germination, purity, etc. After the seed has been stained the seed firm concerned can carry out packing as it wishes, but on each package there must be the crown-stamps, which indicates that it is a State-controlled strain. Further, the variety name and the staining number must be given and a notice must appear to the effect that information can be obtained from the State Central Seed Testing Station about the results of after-control of the seed lot in question by

forwarding the packing or label. If the seed is not genuine as to strain, the purchaser can claim damages.

The Seed Law

As early as the end of the 19th century it was realized that something must be done to check the illegal seed trade which was being conducted in many parts of Sweden and particularly the malpractices of the so-called market trade. In 1897 the Ministry of Agriculture petitioned that a law should be passed to deal with the matter, but it was not until 1928 that the Government passed a "law concerning the trade in seed," which came into force on 1 January, 1929. The law was altered and amplified in 1936. In everyday speech it is called the Seed Law. It embraces all lots of seed intended for sowing with the exception of cereals and pulses together with seed of ornamental plants and forest trees.

The basic principle of the seed law is that the seller of the seed shall furnish the buyer with *written information* concerning such facts and circumstances as are of special importance for estimating the value of the seed for sowing. The law also prohibits the sale of certain lots of seed when their content of weed seeds exceeds certain stipulated limits. For infringement of this law, fines only can be imposed but not compensation for damage. Such can on the other hand be imposed according to civil law regulations.

The information shall be given at latest on the delivery of the seed sold and must be given even if the buyer does not demand it. For all kinds of seed the information shall include the name and address of the seller, the name of the kind of seed and the percentage of viable seeds. For all kinds of seed, with the exception of seed of vegetables, the degree of purity must be stated and the weed content, both the content of all weed seeds as well as of so-called noxious weed seeds. Further, in regard to seed of root crops and vegetables, the seller must furnish information as to variety. For mixed seed it is directed that to a certain extent the composition of the mixture and the germination of the ingredients be stated. Finally, for all kinds of seed with the exception of seed of vegetables it must be stated whether the seed was grown abroad. In the beginning the law directed that for seed sold under the description, cleanings, it was necessary to indicate weed content only and not germination capacity. As, however, this exception was abused so that seed which was almost totally lacking in germination was sold, the law was altered in 1936 so that all seed in which there is an admixture of a certain kind, amounting to at least 15 per cent of the weight of the parcel, is regarded as mixed seed and therefore must be treated as such. Germination of the different kinds of seed shall *inter alia* be stated as soon as the percentage by weight of a kind of seed included amounts to 10 per cent or more.

The prohibition against sale applies to seed of red, alsike, and white clover when the weed content exceeds three times the sealing limit, and to mixed seed when it exceeds four times the sealing limit for timothy seed. This applies as well to the content of all weed seeds as to the content of noxious weed seeds. Certain sales, however, do not come under the seed law. These are wholesale sales between merchants and also between salesmen and growers if they take place without public offer for sale, further, sales from growers to merchants which take place with State-sealed seed as long as the sealing is valid. By public offer for sale is meant all selling at market or by auction and the like, where the seller uses advertisement or propaganda in some form to obtain a sale for his seed. The so-called "hawking trade" (kringföringshandel) with seed is now wholly forbidden.

For supervision of the observance of the seed law the following have been authorized to take samples from parcels of seed: the director of public prosecutions, officials or sample takers at the State Central Seed Testing Station or at State-subsidized seed testing stations together with agricultural advisers and travelling farm foremen of the agricultural societies. The legally taken samples are sent to the State Central Seed Testing Station, which has to notify the directors of public prosecutions concerned of eventual transgressions of the law.

The seed law has proved very useful; as a result of it the poorly qualified seed trade has been improved more and more. It is, however, necessary that effective supervision of the law should be continued.

Measures for the encouragement of seed production.

Since 1907 a subsidy has been paid for the furtherance of seed production, which for the budget-year 1940-41 amounted to 30,000 kr.

Among other Government measures may be mentioned the decree regarding dyeing with eosin of certain imported kinds of seed so that foreign seed can be recognized at once. Further protection for Swedish seed production is provided by the regulation that for the import of seed of meadow plants, root crops and vegetables a licence is necessary from the Ministry of Agriculture.

Since 1911 a duty of 20 öre per kg. has been levied on imported seed of red clover, and of 10 öre per kg. on timothy seed. The desire has been expressed that a duty should be levied on a number of other species of seed of which first-class parcels can be produced in Sweden but of which indigenous production is still insufficient.

Among such species are a number of commercial plants and vegetables.

The first seed growers' associations in Sweden were formed more than 60 years ago (in Östergötland in 1879 and in Skaraborg in 1883) but after having flourished for a longer or shorter period and done very useful work in the sphere of seed production they ceased to function one after the other so that at the turn of the century hardly any appear to have existed. At the beginning of this century, however, an increased interest was taken in matters relating to seed production, due especially to such far-sighted men as N. Hj. Nilsson, A. Elofson and H. Witte. It was Witte who, as head of the Seed Bureau, organized Sweden's seed production during the first world war. About 1910 the seed production associations in the provinces where they had been discontinued were resuscitated and new associations were formed in other provinces. In 1914 a national organization was established, the Union of Swedish Seed Growers, to look after their common interests. From the beginning the associations have shown considerable activity with regard to education by arranging courses of instruction, lectures, excursions, inspections and awarding prizes for seed plots, exhibitions, together with the publication of journals, etc. In many places too they have conducted large-scale experiments on the technique of seed production together with strain trials. In addition seed cleaning depôts have been set up and help has been given to members to procure seed for sowing and to sell the seed produced. The Scanian Seed Growers' Association has taken the initiative in the drawing up of normal contracts for contract seed growers for seed firms, assisted in the distribution of seed plots of root crops so that the stipulated distances between plots of different strains which constitute a risk of crossing for each other can be maintained, and so on. Since 1921 the Swedish Seed Growers' Union has published a journal and arranges State seed exhibitions at which all the seed growers in the country compete. For the benefit of the seed producers it publishes quotations for Swedish seed and crop yields, assists the growers when difficulties arise with seed firms and the authorities and safeguards their interests against any kind of infringement.

As early as 1876 the agricultural society in Halland founded the first local seed testing station. This was soon followed by others; in 1894 there were 23 or one in each province with the exception of Blekinge and Kronoberg. All of them had but a short life, but from 1890 to 1924, however, 17 to 18 were operating. Up to 1886 they were supported by the agricultural society concerned, but from 1887 to 1924 they received a State grant of 10,000 kr. Since the establishment of the State Central Seed Testing Station in 1925 as an independent State institution, the majority of the local stations have ceased to exist: now only 5 remain, namely, in Linköping, Örebro, Skara, Täng near Östersund, and Luleå. They receive a joint grant from the State of 5,000 kr.

Among other institutions which are of assistance in the work of seed production are: The Swedish Seed Association, Svalöf, with its 8 substations; Weibullsholm, Landskrona, Otto J. Olson and Son, Hammenhög, and Algot Holmberg and Sons, Norrköping. They have bred and tested strains and varieties especially suited for different parts of Sweden. The plant breeding stations through their experimental work have solved many problems in seed production.

The large seed firms have also played an important part in the development of Swedish seed production. They have taken the lead when new plant species have been adopted for seed production.

The Development of Sugar-Beet Seed Production

By utilizing the results of scientific research carried out during the decade 1921-31, and by breaking the tradition of depending upon European breeding establishments for sugar-beet seed, the American beet sugar industry has achieved complete independence of Europe. Whereas formerly nearly all sugar-beet seed was imported, the industry in the United States now produces all the seed it needs, with a surplus for export. In addition, better adapted varieties have been developed, and these are available within the price ranges formerly paid.

The most striking example of the benefit from home-grown seed is furnished by the curly-top-resistant varieties released by the Division of Sugar Plant Investigations of the Bureau of Plant Industry. These saved the industry in western United States, and have enabled sugar-beet growing to return successfully to districts abandoned as areas of production for European types of sugar-beet. Removal of the threat of failure to the sugar-beet crop through the continued improvement in curly-top resistance of sugar-beet varieties is shown by the rebuilding of a factory in 1937 in the Yakima Valley of Washington erected on the foundation of a factory abandoned in 1924 because of curly top—the building of new factories in California, Oregon, and Idaho (Nampa) and the re-entrance of the sugar-beet into districts of California, Idaho, Utah, New Mexico, Texas, and western Colorado that, because of curly top, had previously been found too hazardous. To the sugar-beet seed enterprise goes the credit for the seed supplies which made the new curly-top-resistant varieties promptly available to farmers, and in adequate quantities.

Quick replacement of varieties is possible with the sugar-beet, because by terms of the sugar-beet contracts with farmers the beet sugar Company retains the right to furnish the seed. Hence, the Company in its efforts to obtain the most productive sorts is acting as agent for its growers. The Division of Sugar Plant Investigations has utilized this existing relationship between grower and processor to bring promptly to the grower the advantages which have come from any advance made by breeding research.

To appraise the job involved in achieving independence of European sugar-beet seed supplies, not only the total annual seed requirement for the American sugar-beet crop needs to be known but the breakdown of the total into the kinds of seed used in the respective factory districts must also be considered. To plant the 1,061,000 acres reported for 1942, taking 15 pounds per acre as the average planting rate, required nearly 16,000,000 pounds of seed. In itself, the production of seed in such quantity represents a large undertaking. But no single sugar-beet variety, or type, meets the complex needs of our sugar-beet industry. Curly-top-resistant varieties have not shown themselves suited for non-curly top conditions, largely because they are susceptible to leaf spot. On the other hand, leaf-spot-resistant types, because they are not curly-top resistant, would give disastrous results in the western districts subject to curly top. Hence, the total requirement for seed must be analysed with respect to the respective types and varieties needed for the various districts served.

The sugar-beet districts located west of the Continental Divide, comprising about 350,000 acres, are in the curly-top zone and prevailingly require curly-top-resistant varieties. Furthermore, certain districts within this general area impose additional specifications in order that a variety be useful. Thus, California districts in which winter plantings are made require in a variety not only curly-top resistance but absence of bolting tendencies—that is, the variety when planted in December, January, or February must not produce any high percentage of bolters or "seeders" in the first year of vegetative growth.

The sugar-beet districts east of the Continental Divide are free from curly-top outbreak but, in large part, are subject to epidemics of leaf spot, a fungous disease which by the attack on the foliage reduces root yield and impairs quality of the crop. Some districts east of the Rocky Mountains are only slightly affected by leaf spot and, for these, highly productive sorts are indicated and special adaptation of varieties to soil and climatic conditions may be expected to enhance crops.

Many districts of eastern Colorado, those of western and central Nebraska, Kansas, Iowa, southern Minnesota, and the sugar-beet districts of Wisconsin, Illinois, Indiana, Ohio, and Michigan face serious problems because of periodic outbreaks of sugar-beet leaf spot. Their primary requirement is for varieties resistant to this disease, and, when this major improvement is achieved, adaptation to the specific requirements of individual districts undoubtedly will further augment production.

The factual record of the achievement of the sugar-beet seed enterprise is shown by the statistics of acreage, yield per acre, and production as given in Table 1, which covers the period 1933 to 1941 (1). These data were compiled in the Division of Sugar Plant Investigations from reports furnished by beet sugar companies and their associations, the only agencies producing sugar-beet seed in United States. The decisive drop in seed importations to supply beet sugar factories with seed for use by

*Reprinted, by permission, from *Sugar*, Vol. 38. No. 1, pp. 18–23, and No. 2. pp. 22–38. 1943.

Table 1.—Sugar-beet seed: Acreage, yield, and production, all varieties and curly-top-resistant varieties. 1933-41.

ACREAGE HARVESTED

State.	1933	1934	1935	1936	1937	1938	1939	1940	1941
	acres	*acres*	*acres*	*acres*	*acres*	*acres*	*acres*	*acres*	*acres*
New Mexico[1]	158	410	791	1,943	1,360	1,059	1,018	612	2,421
Utah[1]	241	398	464	588	616	766	633	510	688
Nevada[1]	—	—	—	139	135	153	88	43	58
Arizona[1]	—	—	10	1,895	3,452	4,754	4,321	4,255	3,833
California[1]	50	68	407	738	1,001	1,122	953	409	1,334
Oregon[1]	—	—	—	—	—	[5]	301	478	1,469
Colorado and other States[2]	500	725	650	675	500	522	440	261	432
Total, all varieties	949	1,601	2,322	5,978	7,064	8,376	7,754	6,568	10,235
Total, curly-top-resistant varieties[3]	449	841	1,091	2,675	3,206	2,936	3,362	1,768	3,580

YIELD PER ACRE

	pounds	*pounds*	*pounds*	*pounds*	*pounds*	*pounds*	*pounds*	*pounds*	*pounds*
New Mexico[1]	2,689	2,271	1,069	965	1,413	1,560	1,175	1,242	1,601
Utah[1]	1,420	2,358	1,988	2,326	1,883	2,033	1,812	2,475	2,026
Nevada[1]	—	—	—	1,625	1,494	1,498	1,635	1,912	2,156
Arizona[1]	—	—	2,000	1,057	1,549	1,347	1,917	689	1,477
California[1]	2,921	2,359	3,226	2,654	2,965	2,907	2,345	2,732	2,681
Oregon[1]	—	—	—	—	—	[5]	1,835	1,732	1,956
Colorado and other States[2]	1,000	1,100	1,200	1,037	1,000	1,075	649	1,610	1,335
Average, all varieties	1,488	1,765	1,671	1,360	1,712	1,631	1,787	1,127	1,767
Average, curly-top-resistant varieties[3]	2,031	2,340	2,413	1,999	2,012	2,303	1,907	1,934	2,119

PRODUCTION

	bags[4]	*bags*[4]	*bags*[4]	*bags*[4]	*bags*[4]	*bags*[4]	*bags*[4]	*bags*[4]	*bags*[4]
New Mexico[1]	4,246	9,309	8,456	18,740	19,219	16,514	11,955	7,600	38,755
Utah[1]	3,413	9,380	9,224	13,679	11,602	15,574	11,549	12,621	13,936
Nevada[1]	—	—	—	2,259	2,012	2,284	1,447	822	1,261
Arizona[1]	—	—	200	20,039	53,478	64,039	82,854	29,322	56,633
California[1]	1,460	1,592	13,128	19,590	29,654	32,604	22,348	11,174	35,766
Oregon[1]	—	—	—	—	—	[5]	5,527	8,277	28,730
Colorado and other States[2]	5,000	7,975	7,800	7,000	5,000	5,604	2,854	4,202	5,771
Total, all varieties	14,119	28,256	38,808	81,307	120,965	136,619	138,534	74,018	[6]180,852
Total, curly-top-resistant varieties[3]	9,120	19,681	26,329	53,460	64,509	67,616	64,123	34,187	75,870

[1] Seed production chiefly from fall planting overwintered in the field.

[2] Commercial production in Colorado, Texas, Washington, and experimental plantings in Tennessee and Idaho. Seed production in Colorado in part from stecklings grown in June or July plantings, overwintered in pit silos; production in other States from fall plantings overwintered in the field. 160 acres were grown in Colorado with average production 1527 pounds per acre; 225 acres were grown in Washington with average production—1165 pounds per acre.

[3] The curly-top-resistant varieties are chiefly those released by the Bureau of Plant Industry, U. S. Department of Agriculture.

[4] Bags of 100 pounds.

[5] In 1938, a total of 34 acres of trial plantings in Oregon produced 52,340 pounds of seed (included with "Colorado and other States").

[6] Includes in addition to 75,870 bags of seed of curly-top-resistant varieties, 71,064 bags of seed, chiefly improved varieties arising from breeding work of beet sugar companies, 33,134 bags of U.S. 200 X 215, a variety improved in leaf spot resistance released by the Bureau of Plant Industry, and about 784 bags of stock seed of other improved varieties chiefly for use in future commercial seed production.

Bureau of Plant Industry. Compiled by Division of Sugar Plant Investigations from reports furnished by beet sugar companies and their associations engaged in sugar-beet seed production.

their growers as the American enterprise strode forward is shown in Table 2 and graphically in Figure 1. The chart portrays the move from almost complete dependence on Europe for seed after World War I to complete independence, beginning with the out-break of war in Europe. Since September, 1939, the American sugar-beet seed enterprise has been growing acreages of seed for the full needs of the beet sugar industry and to accumulate adequate surpluses against a time of need.

The statistics on production as given in Table 1, also indicate how the sugar-beet seed enterprise has shaped its production to fit the demands for the various kinds of sugar-beet seed needed. At the start, the production above the base of about 5,000 bags produced annually in Colorado, chiefly by The Great Western Sugar Company, consisted almost wholly of curly-top-resistant varieties. In recent years, a shift has taken place so that now about 40 per cent of the production consists of curly-top-resistant varieties, the balance being made up of leaf-spot-resistant varieties and of other varieties adapted to specific districts. In 1941, for the total production of seed in the United States over 60 per cent consisted of increases of Bureau of Plant Industry introductions, the balance being chiefly increases obtained by breeding research of beet sugar companies. A breakdown of production by varieties for 1941 is shown in Table 3.

With the entry of the United States into the Second World War, the development of methods of efficient seed production with the breeding of improved varieties has acquired great significance. When the investigations began to produce varieties superior in performance because they were disease resistant or otherwise better adapted, then the domestic seed enterprise became necessary if these varieties were to reach the beet grower. Success has been achieved through co-ordinated effort of the scientists of the United States Department of Agriculture and state agricultural experiment stations, their endeavors being ably supported by the technologists of beet sugar companies to implement the research findings.

Table 2.—Imports and Domestic Production of Sugar-Beet Seed, with Acreages of Sugar-Beets Planted. (Data compiled from Monthly Summaries, Bureau of Foreign Commerce and Navigation, U.S. Department of Commerce, and from Agricultural Statistics, U.S. Department of Agriculture.)

Year	*Importations for Fiscal Year ending June 30*	*Domestic production*[1]	*Acreage planted in spring of calendar year shown*
1913	14,768,207	—	635,000
1914	10,293,898	—	515,000
1915	15,882,661	—	664,000
1916	9,042,490	5,211,000	768,000
1917	14,469,774	5,076,000	807,000
1918	15,635,542	5,900,000	690,000
1919	986,676	6,700,000	890,000
1920	19,338,012	6,770,000	978,000
1921	19,906,906	3,575,000	882,000
1922	4,193,311	1,056,000	606,000
1923	16,494,953	[2]	732,000
1924	11,620,053	[2]	936,000
1925	14,249,938	[2]	781,000
1926	8,733,175	[2]	746,000
1927	14,516,082	[2]	756,000
1928	13,255,322	[2]	698,000
1929	14,068,107	[2]	772,000
1930	15,627,737	[2]	821,000
1931	13,438,762	[2]	760,000
1932	19,498,535	550,800	812,000
1933	15,820,000	1,411,900	1,036,000
1934	18,027,312	2,825,600	945,000
1935	11,339,191	3,880,800	809,000
1936	13,106,324	8,130,700	855,000
1937	15,138,941	12,096,500	816,000
1938	3,117,712	13,661,900	990,000
1939	6,763,243	13,853,400	1,030,000
1940	4,081,892	7,401,800	975,000
1941	nominal	18,085,200	795,000
1942	nominal	[3]18,000,000	1,061,000

[1] Calendar year, hence usuable for plantings in next calendar year.
[2] Production from stecklings; estimated at about 500,000 to 800,000 annually.
[3] Estimated.

Establishment of Seed Enterprise in U.S.A.

The sugar-beet seed program, as we now know it, started with observations in co-operative experiments of the Division of Sugar Plant Investigations with the New Mexico Agricultural Experiment Station. Sowings of sugar-beet seed were being made each month of the year to determine the best planting date for production of roots when it was noted that the sugar-beets planted in late summer or fall survived the winter in New Mexico and abundantly went to seed the next spring. From a project of growing the crop for root production, attention was directed toward growing the sugar-beets for seed, and experimental evidence began to be accumulated as to when and how to grow heavy seed crops (**2**).

It must be made clear that production of sugar-beet seed of itself is not a difficult matter. The normal cycle of events is that any sugar-beet root kept in proper storage over winter will go to seed if it is planted out in the ensuing spring under suitable growing conditions. Since the early nineties, Dr. Harvey W. Wiley, pioneer in sugar-beet research in United States, and others had produced sugar-beet seed crops and had advocated that our beet sugar industry produce its own seed. None of these early attempts resulted in development of a lasting seed enterprise. Brandes (**3**) describes the seed bottleneck in 1914 and the years that followed: "The files of the Bureau of Plant Industry of 1915, 1916, 1917, give a vivid picture of the hectic period of World War days when, by dint of the strenuous effort of the Department of

Agriculture, the Department of State, and only by consent of the British Government, passage through blockade of Germany was secured for meagre amounts of sugar-beet seed, absolutely essential if a sugar-beet crop was to be grown in United States. Such seed as filtered through came in under bond that it would not be re-sold and a bond that the sacks would be returned was exacted ! Such are the grim realities of war time, where such an item as return of gunny sacks could determine whether an American food crop could be grown."

During and just after the First World War, the American beet sugar industry tried to produce seed by the conventional or European method—growing small roots or stecklings, in one season, pitting them in deep trenches over winter, and replanting in the spring. This method is still employed in some areas on limited acreages, especially for choice breeding stocks. In 1919 and 1920 the annual production of seed by this method was about 6,700,000 lb., a figure that gradually decreased in 1922 and subsequent years to less than 1 million lb. This method of producing seed involves much handling of roots, and the labour costs, taking into account the relatively low yields, are relatively high. Production in U.S.A. could not therefore compete with European costs, and the American industry turned again to European sources of seed supply when trade was resumed.

A most important contribution in the co-operative work in New Mexico was made by J. C. Overpeck when he found that if the sugar-beet seed were drilled at about 18 lb. per acre in 22-inch rows in late August or early September and the *seedlings in the drill row were left unthinned,* these plants successfully over-wintered in the field and produced an abundant seed crop the next season. The importance, therefore, of the investigations in New Mexico came from the labour-saving element introduced since the expensive jobs of cutting the tops from the stecklings, lifting and siloing the roots, were obviated. The disappointing results which often occurred because of decay of roots when stored in pits, together with the spring job of sorting the roots from the silos and planting out in the field, were avoided. In essence, by the new method, sugar-beet seed could be grown much as is winter wheat and the way was opened to almost full mechanization in producing the crop.

The first experiments were conducted with European sorts and the early years of experimentation served to determine effective field seeding methods, proper times of planting, irrigation requirements, and fertilizer practices which gave favourable outcome. The early reports permitted the conclusion that seed growing in United States by this method could compete with European production. The first move from experiments in small plots to field production was made when the American Beet Seed Company (now the American Crystal Sugar Company), and The Great Western Sugar Company contracted in 1927-1928 with farmers near Las Cruces, New Mexico, for a commercial production of sugar-beet seed (**2**). The former company continued its production on a small scale for a number of years. Experimental work was also started in California along the same general lines, and this work, together with trial plantings in southern Utah, indicated that many sections of the South-west could be utilized for sugar-beet seed production.

Specialists of the Division of Sugar Plant Investigations recognized that impetus to domestic production of sugar-beet seed would come only when varieties especially adapted to American conditions were available. Hence, the actual launching of the extensive sugar-beet seed enterprise as we now have it synchronized with the introduction of U.S. 1, the first curly-top-resistant variety obtained by the research of the Division (**5**) The absence, at that time, of full recognition of the importance of domestic production of sugar-beet seed and of the significance of adapted varieties was illustrated by the reluctance of a few executives to initiate steps in seed production, and a proposal that the new government variety be turned over for increase in Europe. However, the Division of Sugar Plant Investigations insisted that U.S. 1 must be increased in United States under its supervision, and technologists of beet sugar companies supported the Division in its stand.

The major developments began in 1931 when elite seed of the new curly-top-resistant variety U. S. 1 was apportioned by the Bureau of Plant Industry among the three beet sugar companies in whose districts curly top was most serious. Decisions to introduce the variety were reached in late summer of 1931, after its good field showing under conditions of severe curly-top exposure. The program started under pressure to find farmers who were willing to grow seed, stopping other farm operations to get the fields prepared in time. There was little experience in certain districts to guide the job, but from these pioneer endeavors in several States, stock seed was available in the late summer of 1932 for large-scale increase to commercial seed. A total of 436.6 acres for seed were harvested in 1933, giving a total yield of 877,399 pounds of U.S. 1 seed. With seed available, large-scale plantings of varieties for the commercial beet crop followed promptly, so that in 1934, 35,000 acres of U. S. 1 were grown, and in 1935, 102,803 acres.

The figures in Table 1 tell the story of the advance of American seed supplies to meet the demands of our sugar-beet growing districts. Up until 1936, the increase, other than the con-

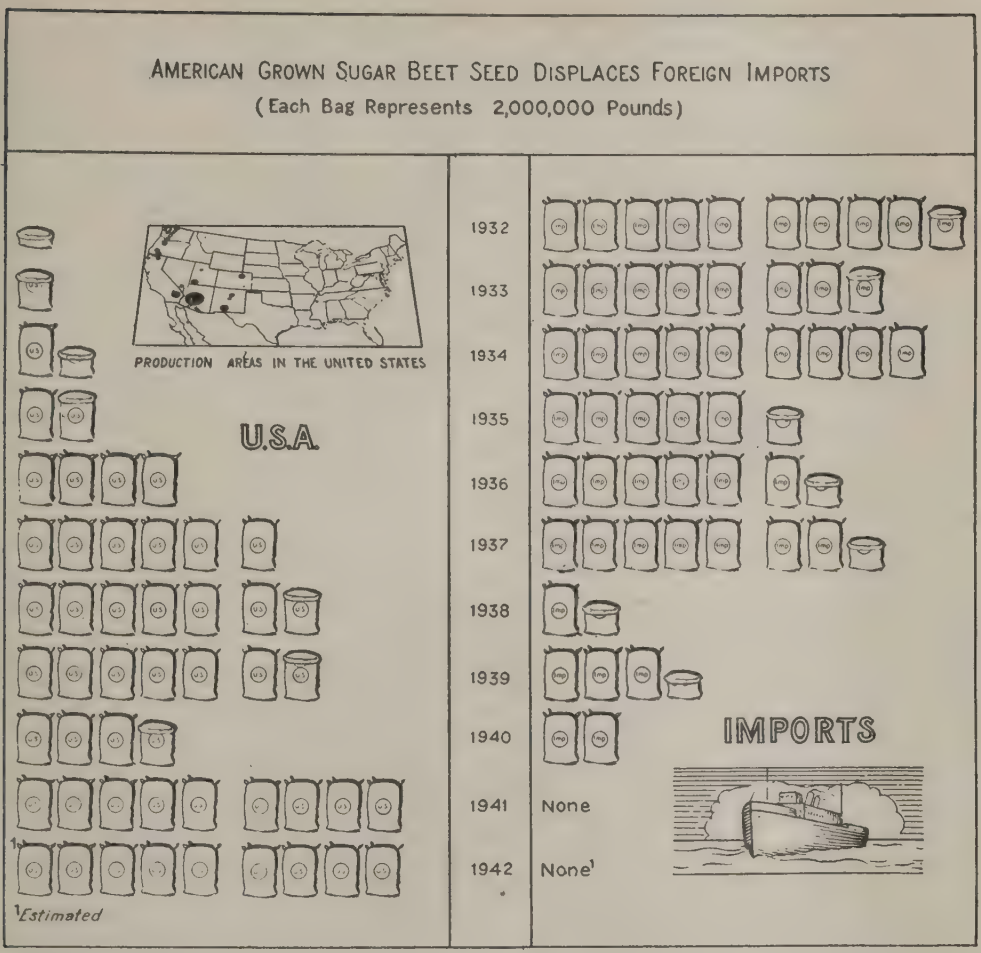

FIGURE 1.

tinued production in Colorado of seed from stecklings, was largely concerned with U. S. 1., U. S. 34, and U. S. 33, the last named varieties, improved in curly-top resistance, having quickly replaced U.S. 1 in 1936 and 1937 (**6**). In the period 1936 to 1939, further impetus was given to seed production by the field-overwintering method when The Great Western Sugar Company, the American Crystal Sugar Company, and the Holly Sugar Corporation began growing not only curly-top-resistant sorts but their own selected varieties to supply their own acreages. These companies began large-scale production in Arizona as well as continuing seed production in New Mexico. Soon European seed firms ceased to supply the west, except for limited quantity of seed for use in early plantings in California; but they continued the chief sources of seed for the more eastern sugar-beet districts. When the European war broke out in September, 1939, the Division of Sugar Plant Investigations aroused the eastern companies to the danger from impending sugar-beet seed shortage and, although late in the season, plans for production of nearly 400 acres of sugar-beet seed to supply Michigan, Ohio, and other eastern States were made. Here again Bureau investigations had available elite and stock seed of a variety bred to meet eastern conditions, since field tests in 1937, 1938, and 1939 with U. S. 200 × 215 in Michigan, Ohio, and elsewhere had shown that this variety could, under leaf-spot conditions, advantageously replace European brands (**7**).

Table 3.—Breakdown by Varieties of the 1941 Production of Sugar-Beet Seed.

Variety.	*Acreage harvested*	*Acre-yield*	*Production 100-lb. bags*
	acres	*pounds*	
Curly-Top Resistant :			
U.S. 15	1,055	1,798	18,975
U.S. 22	1,260	2,358	28,168
U.S. 23	262	2,314	6,055
U.S. 33	945	2,309	21,830
U.S. 10	52	2,119	734
Other U.S. (stock seed)	6	1,700	107
Total Curly-Top Resistant	3,580	2,119	75,870
Leaf-Spot Resistant : U.S. Releases			
U.S. 200 X 215	1,790	1,824	32,639
Other U.S. (stock seed)	79	1,612	1,279
Total U.S. Leaf-Spot Resistant	1,869	1,815	33,918
Beet Sugar Company Varieties : (Leaf-spot resistant and other types)	4,786	1,485	71,064
Total of All Varieties	10,235	1,767	180,852

Commercial Seed Is End Product of Research

Seed production to meet the exacting requirements of beet sugar factories is much more than merely the growing of a seed crop. Actual production of commercial seed represents large-scale operations and faces difficult agronomic problems in that provision must be made to obtain full reproduction and heavy yields. The fields of one variety must be far enough removed from other varieties that cross pollination will not occur. Accurate records of stock seed, close accounting of seed production under each farmer contract, and eternal vigilance in the seed cleaning plant and warehouses all must be maintained in order that the commercial seed be free from contamination and true to name. But this work is the final step in a sequence of controlled scientific investigations and controlled seed-growing operations that started 5 to 7 years before. To multiply the necessarily limited quantity of seed obtained by the breeder to adequate supplies of commercial seed for the farmer to plant takes a long preparation period. No one step in the sequence is more essential than another, but if the breeder has not produced the right sorts for increase there certainly is no advance and there may actually be retrograde movement in both quality and productiveness. Similarly, if the operations of increasing breeders' strains to elite seed and stock seed have not functioned properly, there is a break in the sequence and valuable material and time are lost.

Breeding Investigations

The Bureau of Plant Industry, through its Division of Sugar Plant Investigations, has projects for breeding varieties of sugar beet improved in resistance to curly top, in resistance to leaf spot, and in adaptation to specific areas. In the curly-top-resistance breeding, spectacular advance has already been achieved in production of varieties which withstand exceptionally well all but the most severe curly-top exposure. However, when curly top strikes early and with full force, even the most resistant sorts now available, such as U. S. 22, may fall as much as 20 to 25 per cent below the yields which soil and climatic conditions would otherwise have given. In leaf-spot-resistance breeding, notable advance also has been registered, but with this disease the job imposed on the breeder is exceedingly difficult. Leaf spot does not occur in serious form in every field, every year, but the disease does occur in districts here and there, whenever weather conditions favour the development and spread of the fungus. The breeding programme must find varieties which will withstand leaf spot and, furthermore, these varieties, *if leaf spot is not a factor*, must maintain yields equal to top producers. Hence, among the many highly resistant inbred strains that have been developed, only those can be chosen, or combinations of them can be used, that maintain yield and quality both with and without leaf-spot exposure. Definite progress was made with the introduction of U. S. 200 × 215 as a moderately leaf-spot-resistant variety. It has come into widespread use in the last two years in the more eastern districts, with favourable results. U. S. 215 × 216, which will replace it as fast as seed supplies become available, is more resistant to leaf spot, and, in the absence of leaf spot, maintains high yields (**8**). All resistant varieties, be they curly-top-resistant

or leaf-spot resistant types, obviously show their greatest superiority over non-resistant types when the disease factors impede the susceptible kinds, allowing the resistant ones to forge greatly ahead.

Breeding work of commercial companies also is producing superior sorts, adaptation to soils and special conditions being stressed by some, leaf-spot resistance and curly-top resistance by others. Entrance into the field of breeding by companies, provided the efforts adequately recognize the time and cost factors, should be encouraged as additional moves toward obtaining better foundation stocks. The Division of Sugar Plant Investigations for its own projects cannot feel the job is done until curly-top resistance is still more enhanced in varieties released under government designation and, along with this basic quality, other qualities must be combined so that every important sugar-beet area not only has its major problem of curly-top solved but the accessory problems that arise from special environmental conditions also are adequately met. There is no gain if a variety has high curly-top resistance but its utilization in a district is limited because, for example, it bolts too badly to be usable, or, if it is subject to such severe damage by downy mildew or other disease, that it is not safe to plant. Similarly, a great deal of work remains to be done to produce leaf-spot-safe varieties. None of the leaf-spot-resistant varieties, or the inbred lines from which the varieties are produced, are immune to leaf spot. Under severe epidemic conditions, the most resistant inbred lines are spotted and the leaves as they become mature are killed. The improvement obtained in leaf-spot resistance seems to accrue from the lessened spotting, the lessened effect of the disease on developing leaves and the ability of the leaves for a considerable period after attack to remain alive and working. As leaves mature, even with highly resistant sorts, the leaf-spot fungus can move into the old tissue but, by then, a new foliage bouquet is at hand to take over the job. By contrast with the susceptible sorts, the resistant types remain green long after the others are sere and brown. Those uninitiated in the course of leaf spot are likely to be dismayed on finding under epidemic outbreak of this disease, a field of resistant sugar beets with spotted and frayed leaves, when, at the same time, fields of susceptible beets appear fresh and green. But the resistant beets are showing largely their original foliage whereas the ordinary types have lost one or more flushes of leaves and have put on this green show of foliage at the expense of sugar stored in the roots ! The crackle of dead leaves under foot reveals the situation, and the harvest confirms it. The better of the resistant types now give promise of at least 2 or more tons superiority in root yield and 1.5 to 2 per cent in sugar over the non-resistant sorts under severe, early leaf-spot attack. Although leaf spot will long remain a problem, the degree of resistance now attained is adequate to prevent the disastrous consequences of former blight years when both tonnage and quality were reduced below profitable levels for either farmer or factory.

Growing of Elite and Stock Seed

The second phase in the cycle of seed production is that of the production of elite and stock seed. One of the outstanding developments in this American effort for sugar-beet improvement has been the co-operation of technologists in the industry with the specialists of the United States Department of Agriculture to test, to select, and to increase the best candidates obtained in the curly-top-resistance breeding program. This is accomplished and financed by the Curly Top Resistance Breeding Committee, of which R. H. Cottrell, of the Amalgamated Sugar Company, is Chairman. The Committee is made up of representatives of nearly all the beet sugar companies of western United States. The Committee has the important function of producing supplies of stock seed with which to plant the fields in which the commercial seed is grown. A variety which, for example, will be released for the farmer in 1944 may have first come to attention as an outstanding sort under severe curly-top exposure in a trial field in the summer of 1939. When this variety showed promise, the remnant of seed left after the trial field was planted was put into production to produce an "elite" seed in 1940. In 1940, additional comparison trials of the variety were conducted. If these continued promising, decision had to be made, let us say, in January, 1941, that this variety should replace some previously used variety. Then, in late summer of 1941, large plantings for seed were made under the Committee's contract in order that supplies of stock seed, adequate not alone for 1 year but even for 2 or 3 years of seed field planting, could be produced. Suppose it has been estimated that 20 acres should be grown to produce stock seed harvested in 1942. From the planting made in 1941, there would be harvested in 1942, assuming a 1,500-pound yield per acre, 30,000 pounds of stock seed. If, as guided by advice of the specialists of the Division, decision was reached that the variety should go into massive production for commercial seed, the stock seed available would plant, at 15 pounds per acre, 1,000 acres for commercial seed production, with enough remaining to plant in another year another 1,000 acres for seed. This commercial seed acreage, at the assumed 1,500 pound yield, is likely to give about 1,500,000 pounds of seed in 1943, or enough for growers of sugar beets for the factory to plant 100,000 acres in 1944. Thus, not counting the years of breeding and selection,

from a breeders' strain in 1939 to a commercial seed in the hands of the farmer, there is a span of about 5 years in which the Curly Top Resistance Breeding Committee has been studying, growing, and warehousing valuable stocks in order to place the product of breeding research in the hands of the farmer.

For leaf-spot-resistant varieties developed by the Government, somewhat similar steps are taken as a joint co-operation of the Farmers and Manufacturers Beet Sugar Association, representing the majority of the eastern companies, the New Mexico Agricultural Experiment Station, and the Bureau of Plant Industry. For the government releases of leaf-spot-resistant varieties, a slightly different procedure is required since these varieties are used as F_1's of the single cross of two inbreds, and the job requires production of stocks of seed of the two inbreds.

Beet sugar companies engaged in breeding perform similar functions with their breeding material to produce elite and stock seed of these sorts; it is noteworthy that, irrespective of the company-supported research, these companies belong to The Curly Top Resistance Breeding Committee, supporting its activities to the extent that they depend upon it for stock seed.

Production of Commercial Seed

Thus, two steps of the process have been briefly outlined. There remains the extensive, painstaking, and highly important job of taking the chosen stocks and bringing them to commercial production. The Division of Sugar Plant Investigations has sponsored since its initiation the sugar-beet seed enterprise. It takes justifiable pride that the industry in accepting its leadership has developed smooth working organizations, directed by company technologists, that are meeting the problems of seed supply for American factories. To the scientist the job of producing the basic breeders' strains seems the significant contribution; to The Curly Top Resistance Breeding Committee or any other agency charged with production of stock seed, this function seems the vital link. But to the agencies growing enormous quantities of seed on some 10,000 to 12,000 acres, obtaining the contracts with farmers to grow the crop, making sure that the crop is planted at the right place and at the right time, fighting weather, disease and other hazards, and finally getting the crop harvested, cleaned, bagged, and warehoused, these large-scale, practical operations loom large.

Commercial seed production from the stocks of improved strains is done in two ways in the United States: (1) Individual beet sugar companies, for example, such as the Amalgamated and the Utah-Idaho Sugar Company in Utah and Nevada, or The Great Western Sugar Company, American Crystal Sugar Company, and others, place individual contracts with farmers to grow seed from selected stocks furnished, or even, for special lots, from stecklings which the company may grow; or, (2) a number of companies may associate themselves to form subsidiary companies, essentially co-operative organizations, such as the Western Seed Production Corporation, or the West Coast Beet Seed Company, whose business it is to grow seed acreages on order for the parent companies. The Western Seed Production Corporation (representing the Amalgamated, American, Great Western, and Holly beet sugar companies) is growing seed in Arizona and New Mexico; the West Coast Beet Seed Company, whose stock is pro-rationed among nearly all beet sugar companies in U.S.A., in California and the Pacific North-west. Under both types of approach to the problem, the seed is grown under contracts by farmers, the beet sugar company or the co-operative company supplying the seed, supervising crop growing, and cleaning the seed. By and large, sugar-beet seed growing in the hands of a capable farmer who has followed directions and who has not stinted the crop for fertilizer has been a profitable agricultural venture. Shortage of water, problems of acreage because of high prices for cotton or other competing crops, and shortages of labor have plagued every district. But, in every locality suited to production, this new crop has proved a valuable introduction, contributing to a stable and profitable agriculture. Considering its decade of existence in the older districts and its few years of experience in the Pacific North-west, the success achieved, often with new growers and untried soils, is conspicuous.

The steps in seed growing need not be detailed at great length. They can be envisioned when it is said that the beets are grown as a winter annual and the problems involved are much the same as those with winter wheat. But this is over-simplification. The seed is planted in drill rows, much as is the ordinary beet crop grown for the factory, and, in most sections, must be irrigated up. The timing of planting must be such that the beets before cold conditions check growth attain a size favourable for withstanding winter conditions and yet not be so large that freezing, which is known to kill plants standing far out of the ground, may destroy the stand. Plant size, attained in the fall, must be such that the menace of weeds choking the young plants is met. This weed factor is especially serious in the Pacific North-west where the sugar-beet seedlings need to be large enough to fight weed invaders before fall rains make the ground so wet as to render cultivation impossible. Depending on the area, a fertilizer practice suited to the soil must be followed.

Harvest of the seed in those sections which, with larger acreages, have been able to move

rapidly to mechanization may be compared to wheat harvest by modern machinery. But, on the small acreages, the tall, tough seed stalks are cut by a mower, and hand labor must pick up and shock the stalks for curing. The handling of the shocks to bring them to the thresher entails constant care to avoid loss of seed by shattering. Thresher operators quickly adapted their machines to handle this new crop and, in spite of difficulties, a good threshing job now turns out seed with only about 20 per cent overage of sticks and trash. Cleaning of seed is a special job, which wisely is kept under control of experienced operators in modern cleaning plants equipped with clippers, drapers, and cleaning devices which turn out acceptable seed.

Scientific Research Guides Practice

This discussion has touched on how the enterprise came into being, has told where the job is being done, and how much seed has been forthcoming. It has referred briefly to steps of getting the improved strains (**6**). It has stressed production of elite and stock seed so that finally commercial seed may be grown. It is fitting to turn briefly to the various scientific contributions which make up the 'know-how' of seed growing. At every step in these developments of growing an intensive crop, the pioneer efforts have faced new and difficult problems. The crop has constantly been entering new and largely untried districts, each with its peculiarities of soil and climate. Decisions had to be made on basis of what was known for other districts and these had to be adjusted to new conditions. Hence, it will probably be found that, as experiments proceed, extensive revisions of practices which trace to carry-over from one district to another will be in order.

This is illustrated by experiments on irrigation of sugar beet seed conducted in California which have been published. Overpeck and Elcock (**9**) as a result of several years of trial in New Mexico had shown that for the conditions there, weekly irrigations, beginning at blooming time, were desirable for maximum production of seed and best germination. In the recent contribution, Price and Huberty (**10**) in several years of test show that for Hemet conditions irrigations following the rule of weekly applications showed no significant gains over irrigation as determined by needs of the crop for moisture. One may well assume that these contradictory results reflect the differences in climatic relations. In the work of Overpeck and Elcock in New Mexico, maintenance of high humidities was found to give improved germination, and the weekly irrigation practice was a means of attaining this condition in the field. On the other hand, the readings of field humidities at Hemet by Price and Huberty did not reveal need of heavy frequent watering to maintain high relative air humidity in the field, their readings being essentially the same irrespective of whether irrigations were weekly, at 2-week or 3-week intervals.

Outstanding differences among districts, as would be expected, have been found for fertilizer practices. New Mexico experiments had shown some results from phosphate fertilizer applied in the fall, but not with extremely heavy soils. In this finding, the prevailing practice of heavy manure applications needs to be taken into account. Extensive experiments in Utah by Tolman (**11**) showed decisively that phosphate and nitrogen applications as fall treatments made the differece between good crops and poor to mediocre crops. Experiments by Stoker and Tolman (**12**) in Oregon revealed necessity for boron applications on many soil types. In other experiments, the same investigators (**13**) found that with many soils in the Willamette Valley sulphur applications were essential if the crop was to make proper growth. Furthermore, sulphur was found to play a role in conditioning use by the plant of nitrogen.

Early experiments in New Mexico had determined the value of spring applications of nitrogen as a means of increasing yields of sugar-beet seed. Experiments in other districts are in accord with this practice. Judging from experience with certain other crops, inference might have been made that nitrogen would increase leaf growth at the expense of seed production. Pultz (**14**), in carefully conducted experiments, checked by accurate chemical analyses of the roots of plants going to seed, with and without nitrogen fertilizers, showed that the utilization of carbohydrates stored in the sugar-beet roots was conditioned by the nitrogen available to the plants going to seed. Thus, to obtain full use of the sugars in the beet root, nitrogen must be applied when the plant starts to push up a seed stalk. Clearly, fertilizer practice aimed to meet specific soil deficiencies is determined by the needs of the particular soil type. In contrast to this, where a physiological function is involved, such as with the nitrogen-carbohydrate relationship, the finding may be expected to have general applicability.

The close alliance of basic research to practical objectives has been shown by the studies on the factors which determine whether the sugar-beet growth is to be of vegetative or reproductive phase. It has long been recognized that the sugar beet, as many other plants, requires a period of cold exposure—a so-called rest period—to induce seed stalk formation to take place. The problems involved in this whole matter were strongly brought to attention with curly-top-resistant varieties because of the tendency of U.S. 1, U.S. 33, and other curly-top-resistant varieties to bolt in relatively high percentage when used for winter plantings in California. Some notion of

the practical problem in these winter plantings is given by the report that in one large field in which a root crop of 16 tons was harvested, 9 tons of seed stalks had to be cut and removed before the roots could be harvested. Investigations indicated that the curly-top-resistant varieties were of such genetic composition that relatively slight cold exposure was adequate to induce a considerable percentage of the population to go to seed. Earlier work had indicated that frank annualism in sugar-beets may be due to a simple genetic factor of Mendelian nature (**15**). Such types may be readily eliminated by the plant breeder. But, in the complex represented by the mass selected resistant varieties, a whole series of intermediate responses was involved, seed stalk formation, " bolting," manifesting itself in large or small amount, depending upon the type and duration of cold exposure.

What might be termed the reverse of the problems brought to the fore by bolting of sugar beets when grown for the factory was encountered in seed-growing districts, such as Arizona, and also in southern California where relatively warm winter weather in certain seasons did not give adequate cold exposure to bring all the plants in the field population to seed. It was found that varieties grown under very mild winter conditions frequently had only a limited percentage of plants forming seed stalks, only those with strongest " bolting" tendencies participating in seed production. Thus, a drift in the populations took place so that, when the seed was used in the commercial fields to produce roots for the factory, if spring conditions were cold or backward, heavy bolting occurred in the fields.

Study of this situation by Owen, Carsner, and Stout (**16**) has led to very important developments in the sugar-beet seed enterprise. On the basis of an analysis of the important factors controlling reproduction in sugar beets, progress has been made in classifying varieties as to the types of conditions required in order that full and efficient reproduction may take place. On the other hand, the experience in different sugar-beet seed growing districts, together with meteorological data, has permitted determinations concerning the varieties which should be grown in the respective places. An important development from these and other studies was the suggestion that the Pacific North-west, because of the long, cool winters which favoured induction of the reproductive phase of sugar-beet growth, offered an excellent place for the sugar-beet seed enterprise. As a result, many locations in northern California, Oregon, and Washington have become important in the program. (The early history of the exploratory work by George T. Scott is reported in reference **12**).

Coupled with the thermal effects in inducing fruiting phase are light effects. The sugar beet is a long-day plant, that is, increased day length influences development of the reproductive phase; short day length, on the other hand, making for vegetative growth. The interrelations of light and heat factors are not well understood but, acting together, development of the reproductive cycle goes forward. In nature, the normal timing of operations automatically brings the crop to the period of fruiting when day length is in the increasing phase. In experimental work, both factors are employed, lessening the period from seed to seed.

The investigations have indicated that production of commercial seed may safely be continued in seed-growing areas with warm winter climates if precautions are taken to produce the *stock seed* under conditions of full reproduction and other steps are taken to increase the percentage of plants going to seed. An added safety factor in such productions of commercial seed, since the fructification is chiefly related to cold exposure, has come from the brilliant deduction by Eubanks Carsner in which the quantity of foliage was related to this matter of cold exposure. It had been noticed that early planting in Arizona or southern Utah gave higher percentages of plants going to seed than were found with later plantings. Similarly, sparse stands not only suffered more from curly top but, irrespective of this factor, gave relatively low percentages of plants producing seed stalks. Favorable effects from early plantings and heavy stands have been related to the shading effect of heavy foliage as contrasted to warmer conditions in fields with sparse foliage (**16**). These conditions have also been confirmed by temperature measurements on defoliated beets and on late planted beets as compared with plants in full foliage and in early planted sugar-beets (**11**). Similar direct experimental proof was adduced in artificial shading experiments. Thus, by application of the physiological principles involved, the important seed areas in Arizona, southern Utah, and southern California have been saved as areas of production in the face of what, at the outset, looked like an almost insuperable climatic obstacle.

Problems had to be faced in selecting suitable sites for production of special varieties. Breeding work of the Bureau had developed the U. S. 15 variety which had moderate curly-top resistance and which was very refractory to bolting even if used for early winter plantings. This variety showed superior performance over European sorts in coastal areas of California, and recently has been found especially adapted to the Imperial Valley where sugar-beet culture upsets the normal season in that the crop is planted in October and harvested in April and June (**11**). Application of the principles outlined above indicated that U.S. 15 seed, to retain its characteristic non-bolting character, should be brought to seed in the district most likely to induce one hundred per cent reproduction, such as the Pacific North-west. Crops of seed of this variety have been grown in Oregon, heavy

yields being obtained. The total production of the variety in 1941 amounted to 1,897,500 pounds, the average acre-yield being about 1,800 pounds.

Thus, in the grand strategy of seed growing, scientific research has furnished solutions to many important and pressing problems. Districts have been classified as to their suitability, and study of varietal characteristics has permitted the discriminating assignment of kinds to the places climatically fitted for their reproduction. The investigations have shown how crops of seed profitable for the farmer may be grown and the crop techniques necessary for such production. Disease problems as they arise must rely on research for discovery of control measures. In short, applied research functions to furnish directives whereby practice may proceed with sureness. But this report on scientific research should not be interpreted as minimizing the other part of the job, namely the fruitful application of research findings. Those in the industry who have responsibilities to their companies for vital seed supplies have made, and are making, important and significant contributions. Sugar-beet technologists directing the seed enterprise—many of whom left off research in this Division to go into their present positions—have responsibility for application of research, for re-alignment of program on the basis of scientific evidence and in implementing the findings of laboratory and trial field. They have been in the forefront of making United States independent and secure for sugar-beet seed. The strong forward steps toward greater crop security that come from finding and producing the right variety for the farmer to grow represent a joint effort. An outstanding characteristic of the successful American sugar-beet seed enterprise is this co-operation of science and industry.

The sugar-beet-seed enterprise, therefore, in making its contribution to American agriculture has done two things. It has, in war time, prevented seed shortage from limiting production of vital sugar-beet crops. Furthermore, it has been the agency whereby varieties improved in productiveness because of greater disease resistance or better adaptation have promptly been made available to sugar-beet growers. Although management of the enterprise has resided with the beet-sugar companies, it has, in essence, been the servant of the grower seeking to provide him with seed of the best sorts. Both the beet-sugar company and the grower have a commonness of interest in having the right variety grown in the right place. The value of the attention to sugar-beet seed, both as to kind and adequate supplies, is shown by the rebuilt factories in the curly-top zone, the return of the sugar-beet as a profitable crop in districts one time abandoned, and in the lessened disease losses where resistant varieties have been introduced. It is not too much to say that these advances to fit the sugar-beet varieties better to the respective districts forecast still further progress. The newer discoveries by the plant breeder may not be so spectacular as those resulting from early introductions of curly-top-resistant types. There is, however, assurance of steady and continued improvement. The sugar-beet industry as a whole cannot help but profit by the stabilized production which will come as the crop reaches new and higher levels of performance.

Literature

1. Agricultural Statistics, 1938–1942, inclusive.
2. Overpeck, J. C. Seed production from sugar beets overwinterd in the field. U.S. Dept. Agric. Circ. 20 : pp. 7. 1928.
3. Brandes, E. W. Research on sugar plants and some practical adaptations. *Proc. Amer. Soc. Sugar Beet Technologists* : 1940. 158–164. (Mimeographed). (See *Plant Breeding Abstracts*, Vol. XII, Abst. 504).
4. Skuderna, E. W. The American beet seed industry. Proceedings of the Regional Meeting of the American Society of Sugar Beet Technologists, Fort Collins, Colo., Feb. 7–8, 1939: 9–14. (Mimeographed).
5. Carsner, E. and others. Curly-Top resistance in sugar beets and tests of the resistant variety, U.S. No. 1. U.S. Dept. Agric. Tech. Bull. 260 : pp. 68. 1933. (See *Plant Breeding Abstracts*, Vol. IV., Abst. 210).
6. Coons, G. H. Improvement of the sugar beet. *Yearb. U.S. Dept. Agric.* 1936 : 625-656.
7. Coons, G. H. and Stewart, D. U.S. 200 x 215. A new sugar beet variety resistant to leaf spot. *Sugar J.* 3. N . 2 : 7–8. 1940. (See *Plant Breeding Abstracts*, Vol. XI., Abst. 759).
8. Coons, G. H., Stewart, D. and Gaskill, J. O. A new leaf-spot resistant beet variety. *Sugar.* 36 : pp 4. July, 1941. (See *Plant Breeding Abstracts*, Vol. XII, Abst. 525).
9. Overpeck, J. C., Elcock, H. A., Morrow, W. B., and Stroud, R. Sugar-beet seed production studies in Southern New Mexico, 1931–1936. *New Mexico Expt. Sta. Bull.* 252 : pp. 28. 1937.
10. Price, C. and Huberty, M. R. Irrigation of sugar beets grown for seed. *U.S. Dept. Agric. Circ.* 658 : pp. 7. 1942.
11. Tolman, B. Sugar-beet seed production in southern Utah, with special reference to factors affecting yield and reproductive development. *U.S. Dept. Agric. Tech. Bull.*—(In course of publication).
12. Stoker, G. L. and Tolman B. Boron deficiency relations in sugar beets grown for seed in Oregon. *J. Amer. Soc. Agron.*, 33 : 657-665. 1941.
13. Tolman, B. and Stoker, G. L. Sulfur and nitrogen deficiency relationships in sugar beets grown for seed in Oregon. *J. Amer. Soc. Agron.*, 33 : 1072–1079. 1941.
14. Pultz, L. M. Relation of nitrogen to yield of sugar-beet seed and to accompanying changes in composition of roots. *J. Agric. Res.* 54 : 639–654. 1937.
15. Abegg, F. A. A genetic factor for the annual habit in beets and linkage relationship. *J. Agric. Res.* 53 : 493–511. 1936. (See *Plant Breeding Abstracts*, Vol. VII., Abst. 1018).
16. Owen, F. V., Carsner, E. and Stout, Myron. Photo-thermal induction of flowering in sugar beets. *J. Agric. Res.* 61 : 101–124. 1940. (See *Plant Breeding Abstracts*, Vol. XI., Abst. 428).

UNITED STATES OF AMERICA

VEGETABLES

V. R. Boswell

There is no comprehensive, authoritative, up to date book or single compilation of information on the vegetable seed industry in the U.S.A. "Seed Production and Handling," by Cox and Starr, publishers John Wiley, is considered by some critics to be out of date and to contain a number of rather debatable statements and recommendations. "Truck Crop Plants," by Jones and Rosa, publishers McGraw Hill, contains some valuable information on the production of seed of each of the crops discussed. This information, however, is prepared primarily from the standpoint of the plant itself and not so much from that of commercial practice.

The demand for American grown vegetable seeds is of course far greater now than it has ever been before. American seedsmen have done a remarkable job of increasing production. Between 1940 and 1942 the production of many staple items in the U.S.A. has been increased from two to five times in order to help meet domestic and lend-lease requirements. Some items formerly grown hardly at all in the U.S.A. are now produced on a fairly large scale. Some data that illustrate this situation are reported.

A large proportion of our vegetable seed production is concentrated in the north-western United States and the Pacific Coast States. The arid regions of the West that are rain free at harvest time have obvious advantages over the eastern parts of the country where there is great danger of rain damage on maturing seed crops. Seed beans and peas are extensively grown in Montana, Idaho, Washington, California, Colorado, and Wyoming. Some Eastern seed is produced but it is comparatively minor.

Most of the cabbage seed is grown in the general vicinity of Puget Sound in the State of Washington. Some cauliflower, broccoli, and other crucifers are also grown in that area. Much of the cauliflower and heading broccoli is grown in California. Efforts are being made to develop additional satisfactory growing areas for cabbage and other crucifers. Appreciable quantities of cabbage seed were formerly grown on Long Island and limited quantities are produced in other humid parts of the country, but black leg and other diseases are serious disadvantages.

Most of the bean and pea seed is grown in the arid or semi-arid West because it has been found that seed-borne diseases are much less of a problem on seed from that part of the country. Bacterial blight and anthracnose are two of the worst seed-borne diseases that are largely controlled through the production of seed in areas where those diseases do not prevail.

In the last five or six years extensive vegetable seed growing operations have been developed in the State of Idaho, with a major part of the operations being concentrated in the Boise Valley. Sweet corn, onions, carrots, lettuce and others are grown extensively.

Seeds of the umbelliferous crops, particularly carrot, are grown largely in California and Idaho. Celery is produced chiefly in California, while garden beet seed is produced in quite a number of those western regions that happen to be free of the very serious disease called curly-top. Curly-top affects beets, spinach and tomatoes with particular severity and is most devastating in its effects in the inter-mountain region between the Rockies and the Sierra Nevada mountains. The inter-mountain valleys of Eastern Washington, Oregon and of parts of Idaho, most of Utah and some of the adjacent States suffer such severe losses from curly-top that susceptible crops cannot be profitably produced. Lettuce, chicory and endive are produced over a rather wide range of territory, but again chiefly in the Pacific Coast States and Idaho.

Sweet corn seed is very extensively produced in Idaho, in the corn belt States and also the North-eastern States.

Seeds that are recovered from fleshy fruits are produced much more extensively in the more humid parts of the country than are those seeds requiring dry weather for their proper development. Seeds of cucumber, muskmelon, pumpkin, squash, are grown extensively in California, Colorado, Kansas, the Middle West States and even some of the north-eastern States. As might be expected, watermelon seed is produced chiefly in the warmer parts of the country such as Southern California and Florida, although a few firms in the middle part of the country produce considerable quantities.

Onion seed for many years was produced most extensively in California but the difficulties with mildew have compelled efforts to be made to produce onion seed in areas farther from the Pacific Coast where the air is drier and mildew is likely to be less prevalent. Idaho produces large quantities and lesser quantities are grown in other north-western and Pacific Coast States.

Tomato and pepper seed for planting purposes

are produced rather extensively in several of the areas where the commercial crops of those plants are grown for canning. A great deal of tomato and pepper seed is produced in the Middle Atlantic States and in California. Tomato seed is also produced extensively in the corn belt States.

Since spinach and turnip are such definitely cool season crops, the production of those seeds is most highly developed in the cooler northern States, again largely in the North-west.

These references to principal areas of concentration of production should not be interpreted to mean that seeds of the several crops are not grown elsewhere. Less spectacular quantities are produced in many other parts of the country, efforts being made even in the State of Maine for some of the cool season crops. Considerable production of a number of items will also be found in Michigan, Pennsylvania, New York, but not on such a scale as in the West.

Current Practices.

Practices are as diverse as the crops grown and almost as diverse as the places where they are grown. Up to this year when the Japanese were evacuated from the Pacific Coast a great proportion of the Pacific Coast seed production was in the immediate hands of Japanese farmers working under contract with American seed firms. With the evacuation of the Japanese from the coastal area a very serious production problem occurred wherein the American contractors had to take over the contracts and complete the production operations with whatever help could be obtained. Western areas not subject to the evacuation order have been affected less seriously but of course are facing serious difficulties because of labor shortages.

These war-time labour shortages are necessitating the most drastic efforts to mechanize production operations everywhere possible. Difficulties in obtaining machinery complicate the problem still further.

The growing methods in producing seed of annual crops are not materially different from those followed in the growing of those annual crops for market except that the crops are allowed to stand and ripen seed before harvest. More careful attention is of course given to seed stocks, and some roguing is done when necessary to remove off-type plants from the fields being grown for seed. Generally, however, it is recommended that very intensive roguing be done on stock plots to minimize, if not eliminate, roguing that would be necessary in commercial seed fields.

Seed production of a number of crops is essentially a large scale and largely mechanized operation. Beans and peas are handled essentially like the production of dry beans and peas for food crops, except for the precautions taken to maintain purity. In some of the western areas increasing use is being made of the combine in thrashing dry beans and peas from the windrow or from small bunches or shocks. Beans are first cut below the surface of the soil with a pair of heavy knives on wheels, called a bean harvester. The rows are then rolled together with a side-delivery rake after which they are bunched and cured. They are then either hauled to the thrasher or picked up in place by a combine.

Turnip, mustard, and perhaps some of the other seeds that ripen all at one time are being very cheaply harvested direct in the North-west by the use of the combine. The combine, however, is not adapted to the harvesting of seeds like carrot, celery, lettuce, onion, and others that produce heads of different ages and which therefore may require repeated hand harvesting of heads in order to get the full yield. These last mentioned crops need to be gone over usually two or three times, cutting the mature seed heads by hand and piling them on large sheets on the ground to cure before thrashing. A limited amount of production of such crops is undertaken in the humid parts of the country where these hand harvested heads must be placed on trays in racks in large barns or curing houses before thrashing.

The fleshy fruits like tomatoes, peppers and egg-plants are run through a pulping machine after which the seeds are washed out in large quantities of water, the pulp is floated off, and the seeds collected from the bottom of the washing containers or troughs. Recent work has shown that fermentation of the pulp of tomato for two or three days at 70 degrees will control seed-borne organisms that cause bacterial canker. In saving seeds of melons the fruits are sometimes cut by hand and the seeds scraped out into container where they are fermented slightly and washed out essentially as above. Some growers, however, use a mobile " thrasher " which is driven through the field, the fruits are thrown into it, the seed is retained and the pulp is dropped on to the ground.

Seeds of the fleshy fruits are generally dried out-of-doors, spread thinly on burlap trays. The seeds from the dry mature heads of other crops are usually thrashed by small ordinary grain thrashers, modified as necessary for the seed in question. Peas and beans are generally thrashed with a pea and bean thrasher designed specifically for those crops although it is possible to remove part of the teeth from an ordinary grain thrasher and slow down the cylinder and use that.

One of the principal factors limiting a more rapid spread of seed production into new areas at present is the absence of adequate cleaning and recleaning machinery in prospective areas. The ordinary thrasher of course leaves a great deal of trash and frequently some defective or imperfect seed as the material comes from the thrasher. Specially designed cleaning and recleaning appar-

atus is essential for the final preparation of the seeds for market. Thus far it has not been the practice to ship uncleaned seed any great distance since cleaning facilities are maintained in the several important producing localities. There is a wide variety of cleaning equipment, most devices consisting principally of specially designed screens and fans. Other devices work on a gravity principle, some embody a so-called air flotation method of separating seeds of definite weight from defective seeds or foreign matter.

Heretofore most of the seed of root crops has been grown from roots transplanted by hand at wide intervals in the field where the seed is to mature. About one acre of " commercial " spaced carrots for example will plant about 20 acres of seed carrots. In regions of mild winters the original carrots are allowed to stay in the ground until approximately transplanting time when they are harvested, bagged, and sometimes transported distances of a good many miles to the seed fields. Often of course they are reset in the immediate vicinity. Beet and turnip have been handled in essentially the same way. At present special efforts are being made to find localities having weather such that the roots may be left undisturbed in their original positions for the production of seed in the second season, thus eliminating the hand work and other losses incidental to root harvesting and transplanting. In regions of colder winters the roots are harvested and stored in cellars or pits, then transplanted to the seed fields in the early spring.

Most of the cabbage, celery and other " non-root " biennials grown for seed in this country are produced in areas with winters mild enough for the plants to be left in the field through the winter for seeding the second season without being moved. Some of these crops, however, such as celery may be reset in order to give them wider spacing. In the North-west cabbage plants are set in late summer where they are to stand for the seed crop. Carefully selected stock seed is used so that roguing of the seed crop is unnecessary. The plants are set so late in the summer that hard heads are never formed, but the plants get big enough before winter that they will form seed after going through the period of winter coolness or cold. Parsnips and salsify roots are so hardy that they are commonly left in the ground in their original position over winter.

Some Special Problems

The biggest difficulties at present are the losses of mother roots or mother plants during the winter and second season from disease and adverse winter weather or storage. Carrots are notoriously susceptible to rots, particularly the carotovorus rot. Ring spot on cabbage is causing a good deal of trouble. Mildew is one of the chief problems in producing beet and onion.

There is no particular concern about the problems of producing seed of the annual crops. Most of them can be handled satisfactorily given the requisite land, labor and machinery. The disease problems with the biennials however are very troublesome. Although the biennials are being produced satisfactorily in many places, this production has been worked out principally by trial and error and there is no exact knowledge of the minimum requirements of temperature and day length for getting seed of most of them. This makes it difficult to predict just how they will behave in new and untried areas. American seedsmen for many years have undertaken test plantings in many different parts of the United States with numerous crops. Many of their failures have never been satisfactorily explained or understood. It is believed that many of these " shot gun " trials in the past need not have failed, so much of the ground that others have gone over unsuccessfully in past years is to be gone over again. In the South and the South-west United States the main question is whether the winters will be cool enough to induce seed stalk and flower formation. In the eastern half of the country there is the question as to whether the crops can be properly matured and dried under the prevailing conditions of natural rainfall. At high elevations and in the North the main question is whether winter minimum temperatures are too low to leave seed plants in the field over winter and, if so, how they can be stored most cheaply and safely.

It is believed by some people that investigators in their efforts to keep seed production in rain-free areas have unwittingly gone into irrigated districts where summer temperatures are so high as to interfere with proper pollination and seed development. Studies are now in progress to try to determine the critical temperatures on carrot and beet in this respect. Much western grown carrot seed shows a lower percentage germination and vitality than is desired. And some people feel that the present concentration of seed production of certain crops in the areas where they are now grown is no proof that those are the best places in the country where they can be grown.

American investigators have never been able to obtain the responses to vernalization such as are reported by North European workers. Occasionally small growers will soak seeds of some slow germinating crops to get them above ground quickly, but generally speaking, no use is made of the so-called vernalization practices in this country. If by the term vernalization the combination of temperatures and day lengths required to induce flowering in biennials is meant, then I should say that a good deal of work has been done successfully, but much more remains to be done. The sugar beet people have done the best work in this country along these lines. The requirements for

onion have also been pretty thoroughly worked out, but on other crops the information is still rather sketchy.

In a few areas, particularly in the Puget Sound district of Washington State, seed production has become so concentrated and intensive that we are encountering a real isolation problem. Care must also be taken in growing beet seed not to get garden beets and sugar beets in the same neighborhood. It is generally believed that beets may cross over distances up to several miles under certain conditions. Wild carrot is a common weed in many places which may cause trouble by crossing with cultivated carrot.

Varieties

The subject of varieties is so huge that it is probably best to undertake no treatment of it here at all. Although this country probably tends to concentrate more on a few varieties of each crop than most large agricultural nations, the list of commercially important things runs into the hundreds. It goes without saying that varieties differ in their yields of seed just as they differ in their yields of produce for the market or cannery. Seedsmen naturally like to favor those varieties that are "good seeders" but comparatively little is known about the factors responsible for differences in yield of seed among varieties.

Among the biennials there are very marked differences in response to temperature. Some varieties of cabbage will bolt readily and form seed under conditions that will not induce bolting in others. The vegetable grower wants non-bolting strains for his use while the seedsman wants an easy bolter in order to get seed for the market gardener more easily. A worker is now investigating a slow bolting lettuce that appears promising but the seedsmen won't like it because it will be more difficult to get a seed crop. If, however, it turns out to be a really improved lettuce for much of the U.S.A. the seedsmen will produce seed, although perhaps at higher cost. One of the best quality carrots, Nantes, is known to be a rather shy seeder. Differences in price of seeds of different varieties of the same vegetable reflect in part the ease or difficulty of getting good yields of seed. Differences in demand for varieties of course help determine price.

Legislation, Certification, Etc.

The Canadian Department of Agriculture is probably ahead of the U.S. in the matter of supervising quality of stocks with reference to varietal purity, performance, etc. The U.S., however, has a new Federal Seed Act under which efforts are being made to improve adherance to varietal standards in this country. [Service and regulatory Announcements, No. 156, 1940 and Amendments thereto, 1941.]

The certification of seed potatoes by individual State agencies has long been a successful practice in this country, but only occasional States certify seeds of other vegetable crops. New Jersey, Maryland, and Pennsylvania have certified tomato seed for several years and Indiana has been doing so to some extent. Nearly all States in the country have State seed laws governing purity and germination standards for seeds sold within their respective States. These laws are by no means uniform and some are much better than others, but they all have a beneficial and protective effect. New York State has probably been one of the most active in this regard and their program appears to have been one of the most effective.

Government agencies in the U.S.A. are doing a very good job in helping stimulate production of seeds by established seedsmen for both domestic and lend-lease use. Every possible precaution is being taken to insure that the seeds produced shall meet reasonably high standards of purity and trueness to type. It is really an amazing piece of work that has been accomplished by American seedsmen in the last two years.

This is but a brief outline of the picture; a good book on the vegetable seed industry in the U.S.A. is badly needed and still remains to be written.

T. M. Stevenson and
R. M. MacVicar.

Mangels

Canada sows from 200,000 to 250,000 pounds of mangel seed annually. Until recent years the bulk of this seed was imported. Domestic production of seed has increased from approximately 7,000 pounds in 1939 to 235,000 pounds in 1942. The objective set for 1943 is over 300,000 pounds. The chief areas of production include eastern Canada and the province of British Columbia.

Mangel seed production in this country involves the growing of the seed roots or stecklings in one season, storing them over winter in root cellars or outside pits, and planting them back in the ground the following spring. Some experimental work has been done on the over-wintering of the seed roots in the ground, but the information gathered so far has not been complete enough to warrant commercial production by this method.

Varieties. Canadian farmers prefer the intermediate, half long and long types of mangels, so that seed production is confined almost entirely to varieties of these types. Some of the most commonly grown varieties are Frontenac, Tip Top, U.B.C., Yellow Intermediate (Moore), Prince, and Giant White Sugar (Moore). All these are registered varieties, and the purity of the stocks is maintained through rigid selection. Regulations regarding isolation of seed plots, purity of variety, freedom from disease, etc., as provided by the Canadian Seed Growers' Association, are carefully observed.

Growing the Seed Roots. The seed grower is careful to choose deep, fertile and well-drained soil for his seed roots, and makes liberal use of barnyard manure when it is available. The seed is planted in rows about 28 inches apart at the rate of about 6 lb. per acre. If rigid selection is to be practised, seeding is done early in the spring in order to obtain fully mature roots. For commercial production somewhat smaller roots are satisfactory, and planting is therefore delayed a month or so.

Shortly after the seedlings appear above the ground the rows are wheel-hoed to facilitate thinning. Thinning is done with a hoe, with plant spacing varying from 6 to 12 inches. Following thinning, row cultivation is begun in order to control weeds, and this operation is continued as long and as frequently as the crop requires it. Under most conditions it is usually necessary to hoe at least once in the season to keep the crop clean.

Lifting and Storing Seed Roots. Care must be exercised in lifting to avoid injury to the roots. Hand pulling is usually practised, although the plough is frequently used to loosen the roots. When pulled, the roots are placed on the row at right angles to it. This facilitates selection and topping. Topping is done with a sharp tool such as a butcher's knife, the leaves being cut off about two inches from the top of the crown.

When pulled and topped the roots are allowed to dry sufficiently so that clinging earth will shake off readily, and are then carefully loaded and hauled to the root cellar or pit storage. The root cellar is the most satisfactory form of storage, particularly when temperatures can be maintained at between 32 to 38°F. Sudden changes and extremely high temperatures have been found just as harmful as freezing temperatures.

Outdoor pits are used for storage when root cellars are not available. A well-drained area, preferably a sandy knoll, is generally the location of such pits. Actually, the word pit is a misnomer, since the roots are placed only about 18 inches under ground in a trench from 4 to 6 feet wide. They are piled so that they come to a peak at from 24 to 36 inches above the ground level. Wooden ventilators are placed at 4 to 6 foot intervals along the pit. The protection consists of alternative layers of straw and soil, the number of layers varying according to requirements of the different localities. For minimum temperatures of 30° to 35°F. below zero, a layer of straw 10 to 12 inches thick, followed by a layer of earth of similar thickness is put on for the first covering. When the layer of earth is frozen hard, another layer of straw and of earth, of the same thickness as before, is applied, and this is deemed sufficient to prevent freezing.

Planting Seed Roots. The seed roots are planted on well-manured land which is in good mechanical condition and free of perennial weeds. From 300 to 600 lb. of a well-balanced fertilizer are frequently applied in the spring before planting, although many growers depend wholly on heavy applications of barnyard manure.

The seed-roots are planted in the spring just as early as soil and climatic conditions will permit. They are not removed from storage until the ground is ready for planting. This precaution prevents needless drying out of the roots prior to planting. Small areas are frequently planted by digging the individual roots in with a spade. Larger areas are planted with horse or tractor-drawn implements adapted for the purpose, or by

placing the roots in furrows opened by the plough. Distance between rows is varied to suit available cultivating machinery. The seed roots are spaced 18 to 24 inches apart within the row, the distance varying according to root size. It is considered essential to firm the earth well about the roots.

Cultivation begins as soon as the green leaves appear and is performed as often as is required to keep the crop clean. At least one hand hoeing is given to the crop during the season.

HARVESTING. While the time of harvest varies with the season, the crop is usually turning brown by the first week in August, and the crop is cut by hand at this time and put up in stooks to cure. From 7 to 10 days of good weather is required for curing. Threshing is generally done with the ordinary grain thresher. Care is exercised from the time of cutting to threshing to avoid seed shattering.

An ordinary grain cleaning mill, or fanning mill, is used to give the seed a rough cleaning, while the final cleaning is done on a "draper." The seed keeps well in any dry storage.

Swede Turnips

Canada requires about 150,000 to 175,000 pounds of swede seed each year. In the past most of the seed has been imported, but Canadian production has increased so that in 1943 enough seed should be produced to meet domestic requirements. In 1939 the estimated production was 3,642 lb.; in 1940, 8,526 lb.; in 1941, 54,880 lb.; and in 1942, 70,000 lb., while sufficient acreage is planned for 1943 to make available 216,000 lb., providing normal conditions prevail.

The best seed production areas for Canada are in the Maritime provinces and in British Columbia. Average yields are about 400 lb. per acre, with a range of 200 to 800 lb. per acre. As with mangels the production of swede seed is a biennial proposition. In some parts of Canada, particularly in British Columbia, good seed crops have been obtained from roots over-wintered in the field. Seeding for this method of production takes place between July 15th and August 15th.

VARIETIES. Practically all the seed produced in Canada is from registered varieties such as Acadia, Laurentian, Wilhelmsburger, Bangholm and Ditmars Bronze Top. Rigid selection and adherence to the regulations of the Canadian Seed Growers' Association assure the maintenance of purity in the stocks.

GROWING THE SEED ROOTS. The requirements outlined for mangels apply equally well for swedes, except that it is usually the practice to grow the swedes to full maturity for seed production.

HARVESTING AND STORING SEED ROOTS. While more care is exercised in the handling of swedes in order to avoid damaging the crowns, the lifting, topping and storage is the same as for mangels.

PLANTING SEED ROOTS. It is generally considered advisable to dig the swedes in by hand since they are generally sprouted when taken from storage, and the sprouts break off very easily unless the roots are handled carefully. A spacing of 24 inches in the row has been found most suitable. The land chosen is usually rich and friable and reasonably free of weeds since cultivation is not possible after six weeks of growth.

HARVESTING. When planted as early as possible in the spring the swede seed crop is generally ready for harvest about July 15th. Experiments have indicated that the most seed will be obtained if the crop is cut immediately after the first sign of ripening appears. Harvesting earlier than this results in poor quality seed, while with late harvesting much seed is lost in handling.

The crop is generally cut by hand and put up in stooks to cure. About one week of good weather is necessary for curing. The grain thresher handles the swede crop satisfactorily.

Sugar Beet

Canada requires between 800,000 and 1,000,000 lb. of sugar-beet seed annually to sow the acreage grown under contract for the five beet sugar factories located in the provinces of Ontario, Manitoba and Alberta. A new factory is at present under construction in the province of Quebec, for which additional seed will be required.

Prior to the outbreak of the present world war almost all of the sugar beet seed sown in Canada was imported from Europe. During the years 1941 and 1942 approximately one-third of Canadian sugar beet seed requirements was met by home production. The balance was imported from the United States. A considerable increase in acreage of home-grown seed is anticipated in 1943. Experience has shown that Canadian-grown seed germinates faster and the plants are more vigorous than those resulting from European seed.

Plant breeding in relation to sugar beet improvement has been left largely to the sugar companies. Some very valuable regionally adapted strains have been developed. More recently a Canadian beet seed committee has been organized for the purpose of conducting breeding and selection work on behalf of the sugar companies. The Dominion Experimental Farms Service and the National Research Council have done some work particularly relating to the production of polyploid forms. The Dominion Experimental Farms have also done considerable experimental work relating to the over-wintering of sugar beet roots in the soil for seed production. The production of sugar-beet seed from field wintering of beets has been

developed on a commercial scale in the province of British Columbia as a result of experiments which were conducted, over a period of years, at the Dominion Experimental Stations located at Saanichton and Agassiz in the province of British Columbia.

Seed Producing Areas. There are two main areas producing sugar-beet seed in Canada. In the south-western part of the province of Ontario one sugar company operates two beet sugar factories which process the beets from 30,000 to 40,000 acres annually. In 1941 there were 342 acres of sugar-beet seed harvested in this area. The average yield of seed was approximately 1,000 lb. per acre.

In the province of British Columbia a second seed-producing area has been developed since the outbreak of the present war. This area is located chiefly on the alluvial silt soils of the lower Fraser Valley. A seed-producing organization has been set up in this area which produces seed, under contract, for several Canadian sugar companies. Yields of seed in this area average more than one ton per acre.

The two areas described above differ widely in soil type and in climatic conditions. Consequently, the practices employed in seed production differ so much that it will be necessary to deal with each of the areas separately in regard to seed production practices.

Production Practices. *South-western Ontario*—In this area the seed is sown in rows spaced 22in. apart following corn or some other cultivated crop. Seeding is delayed until well on in the growing season, so that the resulting seed-roots grow only to about one or two inches in diameter before harvest time. Seedings are made at the rate of 10 to 12 lb. of seed per acre and the stands are not thinned. The small seed roots or "stecklings" are harvested with a beet lifter, topped and stored over winter in field pits similar to those described for mangels.

The following spring, usually during early April, the seed-roots are taken from the pits and planted immediately. Any considerable delay in planting the roots after they are taken from the storage pits results in the roots drying out and consequently greatly reduced seed yields. The roots are planted in rows spaced 28 inches apart and spaced from 24 to 28 inches apart within the rows. Planting is done either by hand or through the use of specially designed root planters.

Cultivation begins as soon as the rows are well marked out by green growth, and continues at frequent intervals until growth is well advanced. Some hand hoeing may be done in order to control weed growth.

The seed crop usually ripens and is ready for harvest during early August. The crop is either harvested by hand, using sickles, or by power-operated harvesting machinery. The harvested crop is set up in stooks and allowed to cure for about ten days before threshing. Threshing is accomplished through the use of the ordinary grain thresher or the combine thresher.

The Fraser Valley Area of British Columbia—In this area the winters are relatively mild and the seed roots resulting from the first year's growth are not lifted nor stored over winter but are left in the soil. Successful over-wintering in this area depends largely on choosing the correct time for seeding the crop. Little or no winter-killing results when seedings are made during the period July 10th to August 1st. Earlier or later seedings suffer considerably during some winters. Fifteen pounds of seed per acre is the favoured rate of seeding. The usual practice is to grow the sugar-beet seed crop on summer-fallow, or following a crop of canning peas.

At the end of the first growing season the seed roots average about three-fourths of an inch in diameter. The rows are usually spaced 24 to 30 in. apart. Sufficient cultivation is given, throughout both the first and second growing season, to control weeds.

Under these conditions the seed crop is usually ready to harvest about the first of August. Harvesting is accomplished by means of a specially designed swather which cuts three rows at one time. The swather material is picked up, after it has cured sufficiently, and threshed with a combine-thresher which has been altered slightly so as to better handle the best seed crop.

Fertilization. In all areas emphasis is placed on the need for growing the beet seed crop on fertile, well manured and fertilized soil. In south-western Ontario, the land which produces the seed roots usually receives an application of barnyard manure. In the second year the seed roots are planted on land which has been manured and preferably has also received an application of phosphate fertilizer.

In the Fraser Valley the usual practice is to apply 100 lb. of 6-30-15, and 15 lb. of boron per acre prior to sowing the seed. The following spring, usually during late March or early April, the crop again receives an application of about 300 lb. of 2-12-6 fertilizer per acre. An additional application of 200 lb. of sulphate of ammonia per acre is made during the month of May.

Varieties. Most of the beet seed recently produced in south-western Ontario is of the C.L.R. type. This is a locally selected strain which possesses high resistance to the leaf spot disease caused by *Cercospora beticola*. Some of the hybrids produced by the United States Department of Agriculture are also being grown. Those strains which are resistant to leaf spot disease are highly favoured in this area.

In British Columbia, seed of the variety

FIGURE 1.—An outdoor pit for swedes, ready for straw and earth coverings.

FIGURE 2.—Outdoor storage pit for mangels, showing layers of straw and earth covering over part of pit.

FIGURE 3.—Sugar Beets ready for overwintering in the field. Dominion Experimental Station, Saanichton, British Columbia.

Kuhn P, and the variety Kleinwanzleben, Type E, is being produced for one sugar company which has two factories in southern Alberta. These types are also favoured in the province of Manitoba.

Mother-beet selection is being carried on in most of the factory areas in order to develop highly adapted regional types.

Seed Certification. All seed-producing fields are carefully inspected for isolation. These fields must be separated by at least one-half mile from seed-producing fields of other varieties of garden beets or of mangels. In some areas progress has been made in establishing restricted zones for sugar-beet seed production. The object is to eliminate from these areas other seed-producing crops which can contaminate the sugar-beet crop through cross-fertilization.

All lots of seed are tested for germination and purity before being distributed to growers.

Acknowledgment

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The annual seed requirement of all kinds of vegetables for sowing in Canada is about 8,500,000 lb. On account of the canning industry, the figures for peas, beans, and sweet corn run into very large quantities. In 1939, production of all kinds amounted to 4,960,000 lb., which was short of normal requirements. This shortage was made up by imports from world markets. The goal set for the 1943 production in Canada is 16,594,850 lb., which is calculated to provide for normal requirements and insure a carry-over.

Foundation and Elite stock seed that is used in the production of registered seed under the regulations of the Canadian Seed Growers, Association is produced by the Dominion Experimental Farms and Stations and by other institutions in Canada. The Foundation and Elite stock seed is the highest grade of breeders' stock and traceable to the progeny of single plant lines where possible.

All stocks are carefully checked by pathologists for the presence of diseases and the seed is later subjected to germination tests.

ANNUAL CROPS

Little difficulty is experienced in producing good seed of the various annual crops. The kinds grown include bean, pea, corn (sweet varieties), lettuce, radish, spinach, tomato and the vine crops, which include cucumber, melon and squash.

Bean

Bush beans of both the wax and green podded varieties, including the round and flat podded types, are used for garden and canning purposes. The canners prefer the round podded stringless varieties, while the gardeners use both types.

Varieties

Wax Round Pods: Round Pod Kidney Wax, Pencil Pod Black Wax, Prolific Black Wax, Refugee Stringless Wax.

Wax Flat Pods: Davis White Wax, Wardwell Wax, Golden Wax, Hudson Wax.

Green Round Pods: Stringless Green Pod, Giant Stringless Green Pod, Tendergreen, Refugee or 1,000 to 1.

Green Flat Pods: Masterpiece, Bountiful.

Pole Varieties: Kentucky Wonder (Wax and Green Pod).

A few other varieties are grown to some extent, but are not important.

In all, about 645,000 lb. of seed was produced in Canada in 1942 and the goal for production in 1943 has been set at 800,000 lb.

Seed Production

Seed crops can be grown in all the provinces, with the major production in British Columbia, Alberta, Ontario and Quebec. Well drained, light, warm, moderately rich soil is necessary for maximum returns. This crop works well in a farm rotation since, being a hoed crop, weeds are kept in control. Planting should be done when the danger of a late spring frost is past, which is usually the middle to the end of May. The rows may be from 28 to 36 inches apart with the plants 4 to 6 inches apart in the rows. One bushel (60 lb.) of seed is sufficient to plant one acre. Cultivation should be given at regular intervals, but not while the plants are moist with dew or immediately after a rain storm, on account of the danger of spreading the common diseases, should they be present.

Being a self-fertile crop, the distance for isolation from other varieties is set at 330 feet. Rogueing should be done very carefully to remove off-type plants. When ripe, harvesting is accomplished by using a two-row pulling, power-drawn harvester. Threshing is usually done by means of the regular grain threshing machine, equipped with special speed-changing pulleys.

The yield per acre ranges between 800 to 1,200 lb. of dry seed.

Prior to shipping to market, the seed is given careful fanning mill and hand picking for the removal of small, damaged or diseased seeds.

Peas

Varieties

Canning: Alaska (smooth), Surprise (dimpled), Wisconsin Early Sweet (wrinkled). These are all early maturing varieties, while the following are used for the main crop—Little Marvel, Horal, Thomas Laxton, Perfection, Prince of Wales, Horsford Market Garden, Onward, Admiral, and Green Admiral.

Garden: Little Marvel, Excelsior, Laxton Progress, Blue Bantam, Laxtonian, Hundredfold, American Wonder, English Wonder, Daisy or Dwarf Telephone, Thomas Laxton, Stratagem, Alderman or Tall Telephone.

In 1942 the production was estimated at 12,600,000 lb. and for 1943 the goal has been set for 14,000,000 lb.

Seed Production

Good pea seed can be produced in the same sections as are suitable for bean seed growing, and this type of crop fits into a farm rotation. The best soils include the deep moisture retaining, non-acid; sandy loams; gravelly loams and clay loams. It is important that good drainage be provided for the removal of excess surface water. Some growers find it beneficial to inoculate the seed with nitro-culture before planting. Clean seed should be used to avoid the necessity of seed treatment with mercury dust, since the treatment would off-set the benefit to be derived from the nitro-culture. The time to sow the seed will vary with the locality—from late April to mid May.

Two methods are used in pea seed production:

(1) Seed may be sown in rows 36 inches apart and at the rate of 30 to 40 lb. per acre, which allows for inter-row cultivation and the removal of off-type or rogue plants, and of diseased plants. This method insures a slightly better grade of seed.

(2) Sowing is done with the regular farm grain drill with the rows 7 to 8 inches apart, in which case 90 to 180 lb. of seed per acre is sown. This method does not permit inter-row cultivation and precludes rogueing.

Since this crop is considered to be self-fertile, only a short distance is required to protect against crossing.

Harvesting

The time to harvest varies with the varieties, being done when the pods are well matured, but before there is danger of shattering. Cutting or pulling is done by means of a pea harvesting device attached to the cutter bar of the farm mowing machine. When cut, the vines are bunched to dry for several days. Threshing is done with the ordinary farm grain thresher fitted with speed reducing pulleys.

The yield per acre ranges between 1,000 and 1,800 lb.

Prior to marketing, the seed is fanning mill cleaned, as well as hand picked, to remove inferior and diseased seeds.

Sweet Corn

The popular demand is for the yellow or golden varieties, with a diminished demand for the old white types. Gardeners and canners prefer the varieties suited to the particular locality. The canners' preference is for the mid-season to late varieties on account of the more favourable seasonal conditions in the late summer and early autumn, since the cool weather tends to keep the corn in condition longer and allows for a larger pack.

Varieties

Early: (70 to 80 days from planting to ready to use): Banting, Golden Gem, Sunshine, Goldban, Golden Bantam and Hybrid and Top-crossed varieties.

Mid- season to Late: (85 to 130 days from planting to ready to use): Golden Giant, Bantam Evergreen, Hybrid and Top-crossed varieties.

Late White: include Stowell Evergreen, both narrow and wide grain, and Country Gentleman.

Production in 1942 was 30,000 lb. The 1943 goal for seed production has been set at 500,000 lb.

Seed Production

Being a warm season crop that requires well drained, deep, rich, moisture-retaining soil and a frost-free season of from 90 days in the case of the early varieties to 130 days for the late maturing ones, it has been found that production is restricted to certain regions. The chief seed growing regions are British Columbia, Manitoba (South), Ontario (West, South and East), and Quebec (South-West).

Soils and Preparation. The best soils include sandy loam, gravelly loam and clay loam. The light soils are usually used in the short season sections. Well rotted manure and in some cases a combination of manure and commercial fertilizer are used. Thorough preparation of the soil prior to planting is very important. Growing in a four-year rotation is a good practice to follow.

Seed. Growers are advised to obtain the best pedigreed seed available that has a clean bill of health. Treatment with standard fungicides has been found beneficial in most cases.

Isolation and Production. As sweet corn is an open or wind pollinated crop great care has to be exercised to plant varieties at least one mile apart and preferably with a natural barrier, such as a wood, to check the free drifting of pollen. The planting of varieties in the direct path of the prevailing winds is to be avoided. Inbred strains used in the production of hybrid corn are produced and maintained under control by the use of paper bags as covers for the tassels and ear silks. This work must be done with great care. Seed produced in this way is used in both the single and double cross method of seed production.

In the case of top cross corn, one inbred parent is used. The hybrid and top cross corn gives greater uniformity of crop, both in size of ears and vigour of plants.

Planting. The time to plant is when the weather has become warm and settled, coupled with a warm soil temperature. Planting in hills spaced 3 by 3 feet apart and dropping 5 to 6 kernels in each place is a common practice. Twelve to fourteen lb. of seed will be required for an acre. Cover the seed to a depth of 2 inches in the soil. When the plants are well established, thin to three or four good plants. Row planting is also used, with the rows 3 feet apart and the seeds planted in order that the plants may be from 12 to 16 inches apart in the rows.

Cultivation and Care. As soon as the plants are above ground, shallow cultivation should be given at regular frequent intervals.

Off-type plants and those affected with smut should be promptly removed when first observed.

Plant Selection, Ear Selection, Harvesting and Seed Drying. Strong upright plants that produce well filled ears should be selected and carefully tagged for later observation when ripe. The ears should be broken from the stalks when the husks become loose and have turned white. This may be done by hand or by means of a mechanical picker. Ears with the husks on should not be allowed to stand in piles, but should have the husks removed immediately and the stripped ears placed on special slatted racks or hangers to dry. Spoilage can be prevented if the ears are kept well separated and a free circulation of warm air maintained. It is important to complete the harvest and drying in advance of freezing weather. When dry, the seed should not contain more than from 10 to 12 per cent moisture. The best seed corn is finished drying by means of warm air circulated through the drying room, but at a temperature not above 75°F. Very high temperatures tend to devitalize the seed.

Yield of Dry Shelled Seed

The yield per acre will vary according to varieties. Early varieties will produce about 900 lb., while the later large growing varieties may vary from 1,200 to 1,700 lb. Type of soil, fertility and the season all have a definite bearing on the yields.

Shelling, Cleaning and Storing

Mechanical shelling machines, either hand or power driven, are used, but for the production of the best seed, hand shelling is employed. By the hand method, the ears are usually carefully examined and the small tip and large butt kernels removed. The minimum amount of injury will be done to seed shelled by hand. Fanning mill cleaning is necessary for the removal of chaff, pieces of cob and small or cracked seeds.

The well dried seed may be stored in clean cotton sacks in a closed, cool, dry, mouse and rat-proof granary.

Lettuce

Good seed of the various kinds and varieties can be grown in all the provinces, but the best yields can be obtained in parts of British Columbia, Manitoba, Ontario and Quebec.

Varieties

Loose Leaf: Grand Rapids, Simpson.
Heading: Hanson, New York and strains.

The production in 1942 amounted to 50,000 lb. and the goal for 1943 has been set at 70,000 lb.

Seed Production

The best results are obtained where the plants have been started under glass, and grown to a suitable size during a period of about five weeks before being set out in the field. Planting should be done after the danger of frost has passed. The rows should be spaced 3 feet apart with the plants 12 to 18 inches apart in the row. Shallow cultivation should be given at frequent intervals. During the growing season the plants should be checked over for trueness to type and, before bolting to seed stalks, the off-type plants should be rogued out.

In the case of the heading kinds and varieties, it is necessary to split the heads to allow the seed stalks to develop.

Since lettuce does not cross readily, short distances of isolation are all that are required.

The control of diseases and insects should be promptly attended to by the use of dusts or sprays.

Soils. The well drained but rich moisture-retaining loams are the most suitable for lettuce. It is important that the crop should be grown in a rotation.

Harvesting

Since this crop ripens its seed very unevenly, it is the usual practice to harvest by hand picking the first ripe seed clusters. When the major part of the plants shows a large proportion of seed well developed, the whole stalks are then cut and stooked or stood up on a ground sheet to mature. Threshing by means of the regular threshing mill may be done and the seed cleaned with the fanning mill. Where small lots are produced, hand threshing with a flail may be adopted and fanning mill

cleaning done. Water washing improves the grade of seed, since the very light grains will float and can be removed. Drying should be done immediately on fine cheesecloth screens.

The yield per acre is about 75 to 100 lb.

Radish

Varieties

The turnip and olive shaped varieties are in greatest demand, with the white long types used to a limited extent.

Saxa, a small round red rooted variety suited for forcing.

Scarlet Globe, a medium to large red rooted variety used exclusively for both forcing and field culture.

Scarlet Turnip White Tip, a turnip variety with red body colour and a white base and tap root.

French Breakfast, a very popular elongated or olive shaped variety with red body and a white base and tap root.

The production in 1942 amounted to 190,000 lb., while the objective for 1943 is set for 214,500 lb.

Seed Production

Two methods are employed with this crop :—

(1) The seed is sown in hotbeds or a greenhouse and the plants grown until marketable size has been reached. The roots are then pulled and sorted for trueness to type. The good type roots are topped so as to leave about 0.5 to 0.75 inch of the leaf stalks. These roots are then transplanted into the field after the danger of severe freezing has passed. The rows should be 36 inches apart, with the roots spaced 8 to 12 inches apart in the rows. This method is employed where very choice seed is being produced.

(2) The seed may be sown in the open ground as early as possible—the earlier the better. Seeding at the rate of 3 lb. per acre will give a good stand of plants. When the marketable stage has been reached, thin the plants 8 to 12 inches apart in the rows. Cultivate frequently to keep free of weeds.

Where either method of growing is used, rogueing out the off-type plants should be done. All off-types should be pulled out when the first flowers open.

The yield per acre is in the neighbourhood of 600 lb.

Isolation. Since fertilization of the flowers is effected by insects, it is very important that seed fields of different varieties should be separated by at least a quarter of a mile.

Harvesting

As soon as the pods show signs of ripening, which is indicated by a change from green to straw brown, the stems should be cut off close to the ground by means of a mowing machine, reaper or scythe. The cut stems are gathered into bunches to dry. Threshing is done with the regular threshing mill, cleaning with a fanning mill, and only the large, plump seed saved.

Storage. Since this type of seed dries slowly it should be spread thinly on a good floor in an airy room and stirred daily. When dry it may be stored in close cotton sacks.

Spinach

Varieties

The smooth and savoyed types are used for both market and canning purposes. Longstanding Bloomsdale is a very popular savoyed or wrinkled variety. Giant Nobel, also known as Gaudry, is a smooth, thick leaved variety, and likewise King of Denmark.

There are a number of other varieties in use but the ones mentioned above are the most popular. Production in 1942 amounted to about 53,000 lb., while the goal set for 1943 is 54,200 lb.

Seed Production

Being a cool season crop the seed is usually sown as soon in the spring as soil and weather conditions will permit. Moderately rich, deep, moisture-retaining, but well drained, loam soil is desirable. Acid soils should be avoided.

Sow the seed at the rate of 3 lb. per acre in drills spaced 30 inches apart and thin the plants to 6 inches apart in the row.

All off-type plants must be removed before the seed stalks appear. It will be necessary to do this two or three times while the plants are in the rosette stage. Vegetative male plants are also pulled out as soon as recognizable.

Isolation. Being a wind pollinated crop, it is important to separate seed fields by at least a quarter of a mile and out of the path of prevailing winds.

Seed Plot. To maintain the true type, it is important to have a small seed plot where only very choice plants are allowed to go to seed. The progeny from such a plot is then used for sowing the larger areas the following year.

Harvesting and Threshing

As soon as the seed has reached the firm stage on the majority of the plants and before shattering is liable to take place, cutting with a

scythe or mowing machine should be done and the plants gathered into bunches to dry. Where small acreages are grown, hand pulling is practised, and the harvested plants placed to dry in an upright position against a single pole rack in the form of a long stook.

The regular farm thresher is used for extracting the seed. The seed is spread thinly on a close floor in a well-ventilated room, stirred frequently to prevent spoilage, and, when dry, placed in sacks and stored in a dry, cool place.

The yield averages about 800 lb. per acre.

Tomato

Varieties

A number of varieties are used, according to the purpose for which they are intended, as well as the length of season under which they are to be grown.

In the short season localities, earliness of maturity is very important, coupled with good quality and yield. The most widely used early varieties include Abel, Earliana, First of All and June Pink.

For the longer seasoned sections, where market gardening is carried on extensively and where crops for canning are grown, the following varieties are chiefly used: Bonny Best, John Baer, Scarlet Dawn, Pritchard and Marglobe. Livingston Globe is a standard pink variety.

Seed Production

There has been a gradual increase in seed production from 942 lb. in 1939 to 7,000 lb. in 1942. The objective set for 1943 is 8,600 lb.

Seed growing is confined to the longer seasoned sections on account of the larger amounts of seed obtained per acre.

The tomato crop fits well into a regular rotation on the loam and light soils. Fertility should be high and good drainage is extremely important, whether provided by surface or underground drains. The best yields are obtained from the deep, rich moisture-retaining soils where late spring and early fall frosts do not occur.

Well-grown stock plants that have not been severely checked to maintain them as small plants have been found to give best results. From seed sowing in hotbeds or greenhouses to field planting, it has been found that from 6 to 8 weeks will give about the right type of plants for setting out.

During the time the plants are in the cold frames, spraying with Bordeaux mixture 4-4-40 will aid in the prevention of *Septoria* and other diseases common to this crop.

Isolation. Crossing between tomato varieties is limited, but to insure against this danger about one-eighth of a mile will be found satisfactory.

Planting, Rogueing. The plants should be planted with extra space to allow for normal growth, good cultivation and for rogueing. All off-type plants should be pulled out as soon as noticed. The best type plants should be marked and the fruits from these saved for seed extraction.

Harvesting

Only well ripened fruits should be picked and in some cases picking is not done until about one-quarter of the fruits are well ripened. By this means a considerable volume of fruit will be available for processing. Picking is done by hand and the fruits put into bushel hampers or boxes. To avoid mechanical mixing, one set of the hampers or boxes should be used for each variety. All the equipment should be thoroughly cleaned by washing.

Seed Extraction

Where a high grade of seed is produced the hand method of extraction is employed. The ripe fruits are cut equatorially in halves and the cut surface rubbed on a coarse screen made of quarter-inch mesh hardware cloth screening. Beneath this a second fine screen is placed to catch and hold the seed and pulp.

The seed and pulp are then placed in glass or earthenware containers or clean wooden tubs. A slight amount of water is added that is sufficient to float the mass. Fermenting is allowed to proceed in a warm place for 48 hours. Oak barrels of 40-gallon capacity are used as fermenting vats. Stirring is necessary to prevent caking and discolouration of the seed. Care must be taken to guard against sprouting. Washing is done in a fine cotton bag in fresh running water, until all the slimy seed coat has been removed. The seed is then spread thinly on cheesecloth screens and dried rapidly in a warm, well-ventilated place, with frequent stirring to prevent caking or lumpiness.

When dry, the seed is stored in fine cotton sacks and placed in a cool, dry warehouse.

Pulping or seed extraction in commercial production is done by means of a regular pulper that is power driven.

The yield of seed varies with the different varieties, from 6 to 9 lb. per ton of ripe fruit.

BIENNIAL CROPS

The production of seed of the biennial crops is more difficult owing to the necessity of overwintering the stecklings in root cellars, or pits, or as in the case of onions in a dry, dark, frostproof, above-ground store room.

Root cellar storage has been found very satisfactory for all root vegetables and cabbage, since the temperature control and ventilation can be regulated more satisfactorily during the storage period than in the case of outdoor pits. The outdoor pits, however, are used by some growers to a considerable extent with fair results, although temperature control is more difficult.

Beet

Varieties

Only a few varieties and strains are grown, including: Flat Egyptian, used as a first early variety; Crosby Egyptian, used as a second early variety, and Detroit Dark Red, with its many selections, used for market garden, home garden and canning.

Seed Production

There has been an increase in production from 5,429 lb. in 1939 to 27,000 lb. in 1942, with the goal set for 1943 at 157,000 lb. It was estimated that the latter figure would provide seed for normal home consumption and allow for a portion of the normal carry-over.

Very good seed can be grown in all provinces in Canada, with the major production in British Columbia, Ontario and Quebec.

Stecklings Production. The deep, well-drained, fertile soils are preferable and require to be enriched with a liberal application of barnyard manure. Seed is sown in drills spaced 28 to 30 inches apart at the rate of from 4 to 6 lb. per acre. Where careful selection for type, uniformity of shape, and colour of roots, is to be made it is important to sow the seed by May 20th, thus producing large but shapely roots. For ordinary production, seed sown as late as mid July will produce suitable but smaller stecklings.

When the seedlings are above ground, wheel-hoeing should be done close to the plants, followed by thinning. It has been found that from 4 to 5 inches is a satisfactory distance between plants in the row. Inter-row cultivation should be given twice or three times with one or two hoeings to control weeds.

Harvesting and Storing Stecklings. The best time to harvest is on a dry, clear day and just before frost damage is liable to occur. Hand-harvesting is recommended to avoid damaging the stecklings through bruising. When pulled they should be laid crosswise of the row with the tops pointing in one direction, thereby facilitating selection. The typical roots are picked out and the tops cut off with a large sharp knife, one inch above the shoulder of the root, care being taken that the terminal bud is not injured. After pulling and topping has been completed, they are allowed to dry sufficiently so that adhering soil will fall off.

All selected stecklings or roots should be checked for internal colour by cutting a V-shaped nick one-half to three-quarters of an inch deep, vertically in one side of each root, depending on the root size. By this means the best dark coloured roots can be selected for storage.

A frost-proof root cellar with an earth floor and provided with fresh air inlet ducts in the floor and ventilator outlets in the roof is necessary. Bins constructed with 6-inch wide strips of lumber with a three-quarter inch space between each strip will provide air circulation and prevent heating. The floor as well as the walls should be made of these slats. Very select stock should be carefully packed by hand in small bins. To prevent severe wilting a small amount of slightly moist sphagnum moss should be lightly sprinkled among the roots as they are being placed in the bin. When full, a layer of moss spread over the stecklings will prevent wilting.

The best temperature for storage is 33°F. and 36°F. It is important to maintain an even temperature throughout the storage period.

Storing in pits is employed to some extent, but is not as satisfactory as the root cellar method. A well drained site should be selected, preferably a sandy soil where water will not lodge. First is excavated a shallow trench 14 to 18 inches deep by 4 feet wide and as long as required. It is not wise to make the pit much longer than 18 feet. The stecklings are piled in the form of a long pyramid, with vertical 6 × 6 inch board ventilators placed at intervals of 4 to 6 feet apart along the deep part of the pile of roots, extending from the bottom of the pile and protruding above the pit at least 3 feet. Auger holes in the sides of the ventilators allow for the escape of excess moisture. Alternate separate layers of dry straw and soil 10 to 12 inches thick are applied. When the first layer of soil covering has been frozen, the second is then applied until three or four alternating layers have been put in place. This should be sufficient to protect against freezing. The temperature should be checked inside the pits by means of a thermometer hung by a cord in one or two of the ventilators.

Spring Planting of Stecklings for Seed Production. Well prepared manured land should be used for the seed crop. An application of a balanced commercial fertilizer at the rate of 300 to 600 lb. per acre, depending on the amount of manure previously applied, is frequently used, with good results. Many growers who have an ample supply of manure depend on this as a source of plant food.

Planting out should be done in the early

spring as soon as the soil is dry enough to work. Before the roots are taken to the field all soil preparation should have been completed. The roots require to be protected from drying out by immediate planting. Covering the roots in boxes, with wet sacking or moss, will prevent loss of moisture if planting has to be delayed. Planting of small lots by digging holes with a spade is satisfactory or, where large lots are to be planted, furrows can be opened 36 inches apart, with a plough. The roots are then set out 18 inches apart and enough soil filled in to cover the apical end about one inch. The soil is pressed firmly about each root. When the seed stalk is above ground, the furrow can then be filled in completely.

Frequent cultivation should be given to control weeds and hoeing done when necessary.

Isolation. Since there is danger of crossing between beet varieties, fields should be separated by a natural barrier, such as a wood, and out of the path of prevailing winds, with a distance of one mile separating the fields. This will give very satisfactory isolation and insure the purity of the varieties.

Harvesting.

As soon as the plants take on a brown tinge, which is about mid-August, harvesting by hand should be done. The whole seed stalk is cut off close to the old root crown and stood up to dry in stooks on squares of canvas or other material. One or two weeks of good weather will complete the curing, after which threshing can be done with the regular grain threshing mill.

A good fanning mill cleaning and the use of an adjustable canvas belt draper will remove refuse and sticks.

When completely dry, the seed is protected against mice and stored in cotton sacks in a cool, dry place.

Seed yields up to 1,500 lb. per acre are not uncommon and under very good conditions 2,000 lb. per acre are obtainable.

Carrot

Varieties

The principal varieties grown are Chantenay, Danvers Half-Long, Nantes, and Amsterdam, as well as strains of these.

Seed Production

The production of carrot seed in Canada has increased from 14,708 lb. in 1939 to 209,000 lb. in 1942, with the goal set for 1943 at 311,300 lb. The latter quantity will be sufficient to provide for normal requirements and allow for a carry-over.

Seed production of this crop has been largely confined to British Columbia and parts of Ontario, but seed has been grown to some extent in the other provinces in Canada.

Steckling Production. Excellent carrot stecklings can be produced in the rich, well drained, friable, loamy soils. The recommendations as to soil preparation outlined for beet culture apply also to this crop. The well decomposed, black muck soils have also been found satisfactory for carrots. An application of 2-8-16 commercial fertilizer at the rate of 1,000 to 1,500 lb. per acre will be satisfactory. Seed should be sown at the rate of 2 to 5 lb. per acre in drills 18 to 20 inches apart where hand cultivation is given, or 28 to 30 inches apart if horse or tractor cultivation is used. Where careful selection for type and uniformity of shape is to be made, it is important to sow the seed by May 20th, which will give time for the full development of the roots. For ordinary production, seed sown as late as mid June will produce satisfactory stecklings for storage. The late crop as a rule is sown at the rate of 2 lb. per acre, which will give a thinner stand of plants and eliminate the necessity for excessive thinning.

As soon as the seedlings are above ground, wheel-hoeing should be done close to the rows of plants, followed by moderate thinning where needed. From 2 to 4 inches apart is a satisfactory distance between plants in the row. Shallow inter-row cultivation should be given twice or three times, followed by one or two hoeings to keep down weed growth.

Maintenance of Purity of Varieties. Since cross fertilization by insects is liable to occur, varieties should be well isolated by intervening natural barriers and sufficient distance to prevent crossing by this agency. Localities where wild carrots grow should be avoided.

Harvesting and Storing Stecklings. Very careful handling is essential at harvest time, to avoid bruising the stecklings or injuring the crowns. The harvesting operations and the method of storing are essentially the same as outlined for beets.

Spring Planting of Stecklings. The planting of stecklings should be done in rich, friable deep, well prepared land, as early in the spring as possible. The rows should be 3 feet apart, with the stecklings spaced 18 inches apart in the rows. On account of the length of the roots, the practice of digging holes with a spade and planting by hand to insure having the crowns just slightly below ground level has been found to be a very satisfactory method for planting. Cultivation and hoeing for the control of weeds should be systematically done.

Harvesting

Since carrot seed heads or umbels ripen at different intervals, it is necessary to harvest the crop by hand, cutting off the ripe umbels when maturity has been reached. If weather conditions are favourable, drying may be done on large ground sheets. When thoroughly dry, threshing is usually done with a flail, care being taken to avoid breaking the stems into small pieces, as the broken stem material is difficult to remove from the seed. Removal of the bur can be accomplished by rubbing over a sieve or with special cleaning machinery. The final cleaning with a good fanning mill will produce a good grade of seed. Seed that is thoroughly dried can be stored in sacks in a cool well ventilated storeroom.

Yields of seed vary, and from 600 to 800 lb. per acre have been obtained.

Parsnip

Varieties

Two varieties are commonly used, Hollow Crown (the long type) and Guernsey (the half-long type).

Seed Production

The production of seed in 1939 amounted to 2,290 lb., and in 1942 production was increased to 19,500 lb., with the goal for production for 1943 set at 28,200 lb.

The production of parsnip seed is carried on chiefly in British Columbia and Ontario, with a considerable expansion in Prince Edward Island. Very good seed can also be grown in the other provinces, but the industry has not been developed much beyond the areas first mentioned.

Growing Stecklings or Roots. Parsnips require a rich, deep, moisture-retaining, friable soil. Deep soils are required on account of the root penetration as shallow, compact or stony soil tends to cause pronginess.

The preparation and the fertilizer practice for the soil are similar to that for beets and carrots. Seed sowing should be done as soon as the soil is dry enough to work. Ridging the land produces better conditions for seed sowing and cultivation. The rows should be 30 to 36 inches apart and the plants thinned to 6 or 8 inches apart in the row. Seed sowing is usually at the rate of 3.5 lb. per acre, which will give a good stand of plants. Since the seed germinates slowly it has been found that a few radish seeds sown in the same rows come up quickly and act as markers, making it possible to start cultivation earlier. The radishes are removed after the parsnip seedlings are up. Wheel-hoe cultivation should be given, followed by shallow inter-row cultivation and hoeing. The plants require thinning when well established or before the roots become entwined.

Harvesting Stecklings for Storage. In the late autumn before the danger of hard freezing, the roots that are to be dug for storage should be lifted by ploughing one furrow away from each row; the roots are then loosened by means of a spade. The roots should be laid on the ground at right angles to the rows to facilitate selection and topping. The tops should be cut off with a large sharp knife, about one half to three-quarters of an inch from the crown. Bruising in the process of gathering and storing is to be avoided. Storage can be done in a root cellar or pit, as for other root vegetables. In some sections the roots are left in the ground over winter and the digging and selection done in the spring.

Planting out the Stecklings. Deep, rich, moisture-retaining soil is best suited for growing the seed crop. It is important to plant the stecklings or seed roots as early as possible in the spring. Holes should be dug with a spade, deep enough to take the whole roots, and the soil then pressed in firmly so that the crown is slightly below the general soil level.

Isolate the varieties from one another by means of natural barriers to avoid cross fertilization by the agency of insects.

Harvesting the Seed and Threshing

Since the umbels ripen at various times, hand harvesting is generally employed. The workmen usually slings a large sack from his shoulder and after cutting off the ripe clusters of seed places them in the bag. The harvested umbels or clusters are spaced on a large ground sheet in the open field or on a close floor in an airy building. After several days of drying, threshing can be done with a flail or by means of the regular farm threshing machine. To remove light seed, chaff and sticks, the regular fanning mill will be found useful. Storing in bags in a dry, airy storehouse is found to be quite satisfactory.

Seed yields run from 300 to 600 lb. per acre.

Onion

Varieties

A few varieties are grown that represent the leading types best adapted to market requirements, as follows: Flat Red, Red Wethersfield, Southport Red Globe, Flat Yellow Danvers, Yellow Globe Danvers, Southport Yellow Globe, Ebenezer, White Portugal, and Southport White Globe. There is a greater demand for the yellow types for general use, and the White Portugal is used for pickling.

Seed Production

There has been a considerable increase in seed production from 1939 when 24,366 lb. was produced, as against 113,000 lb. of seed in 1942.

B. T. Dickson and
J. R. A. McMillan

Before the war, Australia was mainly dependent upon the United States of America, European countries and New Zealand for her vegetable seeds. Australian production was mainly confined to cucurbits and beans, of which she produced sufficient for her requirements, and tomatoes, for which she was only partly self-sufficient.

The over-running of Europe not only eliminated that source of supply but threw a greater burden on the U.S.A. to provide for other countries which normally depended on Europe. This, followed by the entry of Japan into the war, with a serious threat to the Pacific supply lines between U.S.A. and Australia, placed Australia in a most critical position with regard to vegetable seeds.

Vegetables Seeds Committee

The Commonwealth Government took immediate action to provide the necessary machinery to control the position and established a Vegetable Seeds Committee under the National Security Act. The objectives of this Committee are :—

(i) To ensure an adequate supply of vegetable seeds in Australia ;
(ii) To ensure suitable strains are used in seed production ; and
(iii) To ensure efficient distribution of vegetable seeds in Australia.

The Committee consists of eight members, two representing the Commonwealth Government, one of whom is Chairman, two representing the State Departments of Agriculture, two representing seeds merchants and two representing the growers. In addition to the Committee, an Executive Officer has been appointed. The selection of personnel representing the various interests of the seed industry has resulted in very efficient work being done.

Seed Production Programme 1942-43

The only way in which the Committee could feel reasonably certain of ensuring adequate supplies of seed was to undertake seed production in Australia. It determined the annual requirements of the various species and varieties and the stock position.

In order to provide suitable reserves as an insurance against enemy action, future crop failure and increased demands, the production goal was in most cases set at a figure which would enable Australia to have a two years' supply. Details are given in the accompanying table.

Seeds merchants and private growers were encouraged to undertake the production of seed, but it was soon found that they could not meet the new demands. The Committee, therefore, had to arrange for production as well, and at present seed is being produced by farmers under three different arrangements :—

(*a*) Contracts with the Committee ;
(*b*) Contracts with seeds merchants ; and
(*c*) Crops not under contract.

Producers of crops not under contract have their own clientèle or hope to dispose of the seed to seeds merchants.

In order to enable the Committee to arrange contracts and purchase the seed produced, the Commonwealth Government has provided funds to the extent of £155,000. For the field work on the Committee's crops, the Committee is relying on the co-operation of the State Departments of

VEGETABLE SEED PRODUCTION IN AUSTRALIA 1942-43.

Kind.	*Annual Requirements.*	*Production Goal.*	*Area Reqd.*	*Price offered by Committee.*
	lb.	*lb.*	*acres*	*per lb.* s. d.
Beet—Red ..	72,000	108,000	309	2 6
,, —Silver ..	12,000	24,000	48	2 0
Cabbage ..	14,000	28,000	110	10 0
Carrot ..	54,000	108,000	310	5 0
Cauliflower ..	4,000	6,000	24	30 0
Celery	1,940	2,000	4	17 6
Cucumber ..	8,400	8,400	45	4 0 to 5 0
Leek ..	800	1,000	10	15 0
Lettuce ..	26,000	52,000	208	6 0
Marrow and Squash ..	12,500	12,500	40	2 6
Melon—Rock	4,600	4,600	23	—
,, —Water	12,800	12,800	128	—
Onion—Early Flat White	4,700	4,700	47	17 6
Onion—Other	22,000	22,000	73	—
Parsnip ..	30,000	30,000	60	2 0
Pumpkin and Hubbard ..	27,500	27,500	129	3 6 to 4 3
Radish	24,200	24,200	50	—
Tomato ..	7,200	7,200	122	20 0 to 30 0
Turnip—Swede	100,000	200,000	330	2 0
,, —Table	15,000	30,000	60	2 0
	bushels	bushels		per bushel
Beans—Broad	4,300	4,300	300	—
,, —French	20,000	20,000	1,000	—
Peas ..	60,000	30,000	1,600	15 0 to 20 0

Agriculture. The latter communicate with growers, arrange contracts and provide technical advice throughout the season.

The production of seeds of red beet, cabbage, carrot and lettuce, was considered to be risky, especially because of the lack of experience in Australia; to encourage producers to grow these crops for seed, the Commonwealth Government has provided for compensation up to £25 per acre in the event of crop failure. To encourage production, prices considerably higher than pre-war imported seed were offered (see table). This was found to be necessary in order to attract growers to undertake the production of the crops, as otherwise they would have been able to obtain a much greater return from other farming activities.

The amount of seed required is really not very great and the acreage required to produce it relatively small in comparison with other crops; hence while every encouragement was given, the Committee had to ensure that there would be no over-production. It therefore arranged for a scheme of registration. Under this scheme all vegetable seed crops have to be registered before or shortly after planting; as all the production is co-ordinated by the Executive Officer, it is relatively easy to control the acreage and prevent over-production. An additional advantage of registration is that all the crops, localities, and growers, have to be examined and recommended by an agricultural officer and crops supervised throughout the season. Only growers who are considered satisfactory in every way, and who produce good crops, are registered. If crops are poor or unsatisfactory for any reason, they can be de-registered and the seed cannot then be sold.

Special efforts are now being made to control the "Mother" seed being used for the production of commercial seed crops to ensure that only "Mother" seed from high-yielding, good quality seed, free from disease, is used.

The distribution of the crops by States is shown in the accompanying table. From this it will be seen that the majority of the crops are concentrated in New South Wales and Victoria.

The results of the first season's activities have been very satisfactory, although the goal will not be reached in some kinds because of unfavourable climatic conditions. Nevertheless, it would appear that with the exception of pea seed, some of which will be grown in New Zealand, Australia will be self-supporting as far as vegetable seeds are concerned after this season.

ACREAGES OF KINDS BY STATES. 1942-43 CROP.
(Figures incomplete)

KIND.	NSW.	VIC.	Q'LD	S.A.	W.A.	TAS.	TOTAL
Beet—Red ..	34	131		6		88	259
Beet—Silver ..	9	15				3	27
Cabbage ..	45	9		7		20	81
Carrot ..	99	92		2	1	8	202
Cauliflower ..	13	10		9		9	41
Celery ..						1	1
Cucumber ..	32	11					43
Leek ..	2						2
Lettuce ..	63	25				1	89
Marrow and Squash ..	28	11					39
Melon—Rock	10	2					12
Melon-Water	11	7					18
Onion—Early Flat White	10	5		21			36
Onion—Other	28	162		20	1	3	214
Parsnip ..	6	12				13	31
Pumpkin and Hubbard ..	72	28	34				134
Radish ..	6	7				14	27
Tomato ..	80	9					89
Turnip–Swede	97	202		16		23	338
,, —Table	1	68		3	4	11	87
Beans—Broad		36		2		38	76
,, —French	315	574	6		2		897
Peas	144	978		186		52	1360
Total (in Acres)	1105	2394	40	272	8	284	4103

A. ROOT AND FORAGE CROPS

The Dominion of New Zealand has a temperate climate with in most districts a reliable summer rainfall making conditions favourable for intensive livestock farming. Root and forage crops are grown to supplement pasturage for breeding stock and also for use as specialized fattening crops. In the colder Southern Provinces the proportion of cultivated land devoted to these crops is higher than in any other country, even though considerably less reliance need now be placed on supplementary crops as intensified management of grazing leys and the making of hay and silage have increased the production from grassland.

Prior to the outbreak of war, New Zealand depended on imported supplies for the bulk of her requirements of rape, kale, turnip, swede and mangel seed. Many of the leading English seed houses had their agents in New Zealand, and successfully maintained a reputation for the quality and trueness to name of the seeds supplied. In some cases, no doubt, much of the seed was of Continental origin, but great care was evidently taken in control of the growing, harvesting and cleaning of the seed.

Shortly after the outbreak of hostilities it became necessary to organize production within New Zealand, and to aim immediately at self-sufficiency. Soil and climatic conditions proved favourable in parts of the South Island, and now there is sufficient seed grown for domestic requirements, and in some cases a surplus is available for export. Great attention has been given to development of field technique in specialized seed production, to the improvement and maintenance of purity of stock seed, and to the inspection and certification of the various crops.

The work of plant breeding and selection and the raising of nucleus and mother seed is centred at the Pure Seed Station at Lincoln under the control of the Agronomy Division of the Department of Scientific and Industrial Research. The organization of commercial seed production, field inspection, and certification is the responsibility of the Fields Division of the Department of Agriculture. The new industry has been rationalized by co-operation with the leading seed merchants so as to ensure that a sufficient acreage is grown for local requirements, but to avoid any unnecessary surplus of seed crops having in mind the war-time demands for competing crops.

Rape

This is an important crop in New Zealand being used mainly for intensive fattening of lambs in late summer and autumn. About 200,000 acres are annually grown requiring approximately 4,000 cwt. of seed. Prior to 1940 supplies of seed were imported either from England or from Holland through London; occasionally crops of fodder rape were allowed to "run" for a seed crop, but, except for two or three years at the close of the War of 1914-18, the crop managed in this way was not considered remunerative.

For a few years prior to 1939, the Pure Seed Station had selected pure lines of the two varieties grown—Broad Leaf Essex and Giant,—and a small acreage of each variety was being grown for seed, it being the general experience that locally harvested seed gave a stronger and more even growth than the imported.

The area saved for seed in January, 1940, was only 260 acres; in 1941 it had increased to approximately 1,000 acres, in 1942 to 1,500 acres of certified crops and some 4,000 acres of uncertified, and in 1943 to a total of approximately 7,000 acres. A considerable tonnage from the 1942 harvest was exported to Great Britain and to Australia.

Production of rape for seed purposes is centralized in the South Canterbury district where the rainfall averages 25 in. per annum with normally a dry and sunny harvest period from mid-summer (end December). The soils most favoured are light silty loams and clay loams—the former giving usually a lighter crop of seed but with less risk of losses in harvesting than the latter.

Invariably the best crops are grown on fields ploughed up from grass which has been established for 3 to 6 years. Cultivation must commence early, the first operation being to skim-plough in November/December. The surface soil is thoroughly worked during the next two months until the weeds have all been killed and the soil mellowed. The field is ploughed to a depth of 6-7 in. in February and further cultivated in order to have it ready for sowing by mid-March. Thorough cultivation is the keynote of success. It is essential that the seed-bed should be "mellow" and well consolidated, and that moisture should be conserved in the soil in order to secure a quick, even, and strong strike of seed.

It is difficult to secure good crops following stubble as the interval between harvest and sowing time is too short to get the necessary consolidation, while if the autumn is dry the soil works up in a dry powdery condition.

The field is always rolled prior to drilling. Combine drills are invariably used in New Zealand, and are in fact the only type known there. They

are fitted for this sowing with worn coulters which will not penetrate the soil too deeply. The coulters are set at 7 in. apart and seed and fertilizer are sown down every coulter. Extensive field trials have proved that 5-6 lb. of seed per acre is the best rate of seeding. Water-soluble fertilizers should not be used, the standard practice being to sow 1-2 cwt. of reverted superphosphate. Depth of sowing should not exceed 2 in., and if the soil has been well worked it is not necessary to harrow behind the drill.

Sowing should be completed during the latter half of March in order to ensure a strong plant before the winter frosts which are experienced from May onwards. The field is never stocked. In September the plants commence to "run" and by mid-October the crop will be in full flower. The earliest crops on the lighter soils are ready for cutting by mid-December. This district of New Zealand is subject to hot drying winds frequently of gale force, and for this reason it is important to cut the crop at the correct stage. If left until the seed is fully ripened and black in colour, a great deal may be lost by wind shattering. The crop is therefore cut when, on splitting the lower pods, the seed is seen to be brown in colour. A binder driven by power take-off from the tractor is the most satisfactory for cutting, and if any of the lower pods are shedding seed, canvas seed catchers may be fitted beneath the platform rollers and also under the packers. The crop is stooked in small stooks or the sheaves may be left on a high stubble with their heads up off the ground.

Under normal weather conditions the crop is ready to thresh 10-14 days after cutting. Threshing from the stook is the general practice. If a wooden English threshing machine is used, the whole stook is forked, without separating the individual sheaves, into a waggon fitted with a bag-sheet to catch any shaken seed. The crop may be threshed by means of a combine harvester driven slowly along the rows of stooks; a canvas sheet is rigged in front of the elevator canvas, again to prevent loss of seed through shedding. In threshing there is considerable risk of splitting a percentage of the seed; to prevent this the drum speed is reduced and the concave opened out wide. Dull weather is preferred for threshing. On hot sunny days it is advisable to work only in the early part of the day and from late afternoon, suspending operations during the heat of the day.

After threshing the seed is forwarded to the merchant's store for machine dressing. The yield of machine-dressed seed varies according to soil and management conditions and to the weather experienced during the growing period; an average yield of 10 cwt. per acre may be considered normal.

CERTIFICATION: New Zealand has a well-organized system of seed certification which ensures that certified seed is true to type and free of impurities. In the case of rape, crops are eligible for certification only if grown from mother seed which is derived from re-selected stocks grown at the Pure Seed Station. The field must be approved by a local Fields Division officer, and care is taken to prevent any possible cross-fertilization. Crops of the different varieties must be at a distance of at least one mile apart. Each crop is registered and is officially inspected in early spring and at the flowering stage. The appearance of even an odd plant of charlock, wild turnip or similar weed results in the rejection of the crop. After threshing and before the seed is removed from the field, the sacks are sealed and branded by an officer of the Department of Agriculture who is responsible also for drawing an official sample of the machine dressed seed and for re-sealing of the sacks of dressed seed. The sample is forwarded to the Seed Testing Station for purity analysis, and, if this is up to standard, the line is finally accepted as "Government Certified."

PESTS: Rape crops grown as above described specially for seed make their vegetative growth during the cooler months, and are usually little affected by insect pests. Aphides, diamond-back moth (*Plutella maculipennis*) and white butterfly (*Pieris rapae*) are at times serious pests of crops grown for forage.

DISEASES: The only serious fungous disease of rape is Club-root (*Plasmodiophora brassicae*), but this disease is kept in control by careful rotation, and is not usually recorded in the districts where seed crops are raised. In higher rainfall districts this disease may prove a serious factor, and for this reason work is in progress to test a resistant strain developed by the Plant Diseases Division.

BREEDING: A number of crosses have been made and the progeny selected for testing under field conditions. These include the following:—

(Giant × B.L.E.) × B.L.E. This has outyielded B.L.E. and proved more palatable. It is intermediate in habit of growth between the two standard types.

Giant rape × Chinese cabbage (var. Pekinensis). This cross gives promise of being a quick-maturing form.

Giant rape × swede-like rape—an earlier maturing cross. (Swede × rape) × rape—more palatable type.

Rape-kale × rape—this appears to be later maturing and more productive than Giant.

Kale

The only varieties of kale grown on a field scale in New Zealand are Marrow Stem and Thousand-headed. The popularity of the former variety is increasing, mainly owing to its com-

parative immunity from Club-root and insect pest attack.

Rather less than 100 acres is sufficient to produce the seed required for local sowings annually. The methods of cultivation and sowing are similar to those used for rape, but the work must be completed four months earlier as it has been found necessary to sow about the end of November (early summer) to produce a satisfactory seed crop. The kale crop demands rather "stronger" soils than rape; light soils which tend to dry out in summer are unsuitable.

The seed is usually sown at the rate of 6 lb. per acre, combine-drilled in 7 in. rows. A lighter rate of seeding may give a number of thick-stemmed plants which cause trouble at harvest-time.

Seed is at times saved from a crop which has been grown for forage and left over in the field, but the stems of such crops are thick and woody, and therefore unsuitable for mechanical harvesting.

HARVESTING: The crops flower in October but are about 3 weeks behind rape in ripening. The seed does not shatter so readily as does rape, and so may safely be left standing until a slightly more ripe condition of the seed is observed.

As with rape special care is necessary to avoid splitting of the seed during threshing. The yield of seed is from 8-10 cwt. on the average.

A similar system of certification is in operation as for rape.

BREEDING: Three strains of Marrow Stem kale were selected in 1937-38, one of these is a purple-stem strain, one a green tall stemmy type, and the third a green medium leafy type. This selection work has been continued, and has been commenced also in the case of thousand-headed kale. Increased areas are now being grown for seed production. Many crosses have been made in an endeavour to produce improved forms, and work is now in progress on the cross Tall stemmy × Thousand-headed.

Mangels

The mangel crop is an important one in New Zealand for early spring feeding of dairy cows, but the acreage grown is restricted by the heavy demands which this crop makes on the labour supply. Less than 100 acres is necessary to grow a year's supply of seed.

In pre-war years merchants secured their requirements from English or Continental sources, and only very occasionally was seed grown locally in any considerable quantity. At present the production of seed is more than sufficient for home demands and there is a small export to Australia.

VARIETIES: The Long Red type usually produces the heaviest yields of bulbs, but the Globe varieties show a higher dry matter content. For 1942 the varieties grown under certification were restricted to the following:—Long Red, Red Intermediate, Yellow Globe, Orange Globe, and Half Sugar.

SOILS: The choice is recommended of a well-sheltered situation on a fertile soil of the heavy silt loam type which will not dry out in summer, but which is free-working and well-drained. The crop is best suited to districts where the summer is dry and sunny.

CULTIVATION: Early, deep, and thorough cultivation of the soil is essential for a successful seed crop. There are two methods employed in raising mangels for seed.

(1) By transplanting in spring selected bulbs which have been stored over winter. This method involves the setting out of approximately 20 tons per acre when medium-sized bulbs are used, and the transport and handling of these makes this method costly. It has the advantage of enabling a careful selection for type to be maintained, and so it must be used for the production of mother seed or stock seed.

In New Zealand the bulbs are set along a plough furrow at 18 in. apart, the next round of the plough burying them and leaving only the necks exposed. As a 3-furrow plough is used, the rows are left about 30 in. apart. After growth commences the crop is intercultivated several times to prevent the growth of weeds and to conserve moisture.

(2) The second method, that of transplanting "stecklings", is more commonly used for commercial seed crops. Mother seed is sown thickly in a nursery seed-bed in February, usually being drilled in rows 14 in. apart. The seedlings are left in the seed-bed over the winter during which time the main field is deeply worked and fallowed. The stecklings are lifted in early spring and transplanted by being pressed into the turned furrow while ploughing is in progress in the field. They are set at 12 in. apart in the rows with 30 in. between the rows. The crop is later intercultivated as above-mentioned. Phosphatic fertilizer is usually applied both with the seed and at the time of transplanting.

HARVESTING: Mangel seed shakes readily when ripe, and so it is important to judge the correct stage for cutting. This is when the lower seed clusters are ripening but while the top ones are still green. The flowering stems are sappy and enable the seed to continue filling after cutting. The crop is usually cut with the binder using a sheet under the platform. The sheaves should not be allowed to lie on the ground but should be stooked immediately, and the stooks should be carefully turned if they become soaked with rain.

THRESHING: The crop is ready to thresh when the seed capsules are hard and dry. Threshing is usually carried out by means of a header-harvester to which the sheaves are forked. If the crop has been cut at too ripe a stage, trouble will be experienced at threshing time owing to small pieces of stem breaking off from the main stem and remaining attached to the seed capsules. These are most difficult to remove in the machine-dressing process. Under favourable harvest conditions no artificial drying of the seed is necessary. An average yield of seed is 10 cwt. per acre.

CERTIFICATION: The routine for certification follows parallel lines to that described in the the case of rape crops. As the mangel is wind-pollinated, isolation of 1 mile from other varieties, or from crops of sugar beet or garden beet is insisted upon.

PESTS AND DISEASES: The mangel crop is practically free from attacks by insects in New Zealand. In crops grown for fodder an occasional bulb will be found affected with heart rot (*Phoma betae* Oud.) but this disease can be avoided when the crop is grown for seed.

A virus disease has been recognized both in sugar beet and mangels, and precautions are now taken to avoid the use for seed production of affected plants.

SELECTION AND PLANT BREEDING: The varieties of mangels now being grown are for the most part directly derived from seed stocks imported prior to 1940.

Selections from some of the most widely grown varieties have been made at the Pure Seed Station and seed is now being increase-grown. Breeding work has not yet reached the stage of production of seed for commercial use.

Sugar Beet

Beets are not grown in New Zealand as a source of sugar, but are used to a small extent for winter-feeding of dairy cattle and pigs. Seed supplies from selected roots are produced in much the same manner as described in the case of mangels.

Swedes and Turnips

These together constitute the most important arable crop in New Zealand, the area grown amounting to approximately 400,000 acres per year. These crops form the main standby for the winter-feeding of both sheep and cattle especially in the colder districts. The growing of the crop has been mechanized to a high degree, and, as the crop is fed off in the field by the stock, the labour requirement is not high.

Prior to 1940 practically all the seed used was imported, and a great many varieties were on the market. After the fall of France in 1940 it became a matter of urgency to safeguard future supplies and in that year a number of crops intended for forage were inspected and reserved for seed. In 1941, a total area of about 1,500 acres was sown specially for seed production.

VARIETIES: Among the many varieties formerly imported were quite a number which, although sold under different names, were practically identical in growth characteristics. Under the present system of certification the number of varieties has been reduced to give standard types suitable to the various conditions of soil, climate and utilization under which they may be grown. The varieties are named as follows:—

Name.	*Representing varieties formerly known as:—*
White Fleshed Turnips:	
New Zealand Green Globe	Hardy Green Globe; Imperial Green Globe.
N.Z. Red Globe.	Lincolnshire Red; Red Paragon.
N.Z. Purple Globe	Purple-top Mammoth.
Yellow Fleshed Turnips.	
N.Z. Green-top Yellow	Green-top Yellow Aberdeen; Green-top Scotch; Fosterton Hybrid; Dale's Hybrid.
N.Z. Purple-top Yellow	Purple-top Yellow Aberdeen; Purple-top Scotch; Waite's Eclipse.
N.Z. Green Resistant	Wallace
N.Z. Purple Resistant	Bruce; Wonowon.
Swedes.	
N.Z. Superlative	Superlative; Masterpiece; Success.
N.Z. Grandmaster	Grandmaster; Majestic; Tipperary.
N.Z. Crimson King	Crimson King; Elephant; Monarch.
N.Z. Resistant	Wilhelmsburger Otófte; Green Top.
N.Z. Sensation	Vilmorin; Sensation.

SOIL AND CLIMATIC CONDITIONS: The growing of swedes and turnips for seed has been mainly developed in the colder Southern Provinces of Otago and Southland where the rainfall averages 30 to 40 ins. per annum, where the nights are usually cool, and where there is less risk of loss from drought or insect attack. Some districts several hundred feet above sea level have proved very suitable, as crops there are frequently less subject to dry rot (*Phoma lingam* (Tode) Desm).

The soils chosen should not be too rich; a well drained, sweet, medium loam is the best provided it is sufficiently retentive of moisture to prevent the crop suffering badly in a drought.

CULTIVATION: As in the case of mangels it is necessary to produce stock seed by careful selection of bulbs which are lifted in winter and trans-

planted. The commercial seed crop is produced by autumn sowing—thickly to prevent bulb formation.

The field chosen is preferably an old pasture sward which has been down in grass for 6-10 years, and which can be expected to be free of club-root. (*Plasmodiophora brassicae*)

The field is skim-ploughed in early summer (November), and worked much in the way described for the cultivation of land for rape. Thorough consolidation of the seed-bed is important to bring the soil into proper condition for shallow drilling.

Seed is sown with the combine-drill at 7 in. centres sowing 2 cwt. of reverted superphosphate and 4 lb. of seed per acre. This quantity of seed gives a reasonably dense plant population and results in the production of thin, straight and single stalks—the bulbs rarely developing to a size larger than a hen's egg.

Sowing is carried out in early March. It has been found that, if the crop is sown earlier, many of the bulbs grow too large, the seed stems become top-heavy and tend to break at their junction with the bulb.

HARVESTING: Swedes and turnips are slower to mature than rape, and in the Southern Provinces seed is not ripe until late January or early February. The seed ripens from the bottom of the flowering head upwards, and the earlier maturing pods produce the best seed. The crop is cut when the majority of the pods are golden yellow in colour, and when the seed in the lower pods is of a reddish-brown colour.

The binder is used for cutting and full precautions are taken in cutting, carting and threshing against loss of seed, and splitting in the threshing machine, on the lines above-mentioned for rape. The yield of seed is rather variable, the yield from turnip crops being generally higher than that obtained from swedes, some varieties of which are "shy seeders." For turnips the average yield is from 8-10 cwt. per acre and for swedes 6-8 cwt. Some lines of seed show a heavy dressing loss where ripening has been uneven, or cutting too early resulting in a proportion of shrivelled seed, or where threshing conditions have caused a good deal of splitting of the seed.

Occasionally seed may be saved from a crop grown for winter feed but not fed off with stock. Such crops may run to seed and look promising when in flower, but the final return of seed may be very disappointing owing to the liability of many of the bulbs to collapse with dry-rot. Also, if insect pests have sheltered among the leaves over the winter, these multiply very rapidly when the warm weather sets in, and may seriously reduce the seed yield.

CERTIFICATION: The system of isolation, inspection, branding and sealing for Government certification is carried out on the same lines as for rape crops, additional care being necessary to guard against the possibility of infection with dry rot.

INSECT PESTS: Aphides, white butterfly, and diamond-back moth are the principal insect pests of swedes and turnips, but no attempts are made to control these by spraying on a field scale. Diamond-back moth may seriously reduce the yield of seed in a very dry year.

FUNGOUS DISEASES: Club root, dry rot, and soft rot which frequently attack crops grown for forage, are avoided in the case of the seed crop by choice of district and by agronomic methods.

SELECTION AND PLANT BREEDING: This work has been concerned mainly with an attempt to raise disease-resistant types by hybridization, using as one parent a disease-resistant variety such as Sensation. The soil and climatic conditions at the Pure Seed Station are unsuitable for growing swedes and trouble has been experienced in overwintering selected bulbs.

Carrots

This is a crop of minor importance for stock-feeding purposes, only a little more than 1,000 acres being grown annually. The variety now principally grown is a very high-yielding red variety known as Holmes' Improved which was re-selected in New Zealand.

Production of seed is on a small scale, but follows the same principles as employed for swedes. The crop is frequently cut by sickles.

B. VEGETABLES

New Zealand has only a small human population (1,600,000), consequently the demand for vegetable seeds is comparatively small, and it has in the past proved more economic to import the many varieties required than to attempt to grow them. Seed was in most cases imported from Continental countries where labour was cheap and plentiful, a necessary condition to the cheap production of a commodity which requires a good deal of hand work.

Since supplies from the Continent have been unobtainable, efforts have been made to increase local production, and in this connexion the experience of seed firms has proved invaluable, as they had in previous years grown part of their requirements of some varieties locally.

GARDEN PEAS: For many years New Zealand has enjoyed a reputation for the production of high quality seed of garden peas, and these constitute the only vegetable seed produced in appreciable quantities for export. Statistics of production are confused by the inclusion in the published returns of various varieties of grey and blue field peas in the same category as garden peas.

It is estimated that the area sown annually in garden peas is approximately 8,000 acres.

VARIETIES: Garden peas are principally grown under contract, the grower being supplied with stock seed under a code letter or number and agreeing to return to the merchant the whole of the produce from the stock seed. In some cases the stock seed is imported from English seed houses and grown on their behalf. The varieties being grown are therefore not always identifiable. Those grown "free," or under their catalogue name, include Greenfeast (syn. Lincoln), Onward, Stratagem, Wm. Massey (syn. Kelvedon Wonder), Little Marvel and Yorkshire Hero.

CLIMATIC AND SOIL CONDITIONS: The scope for the growing of peas is rather limited as the crop demands, firstly, a climate where the harvest weather is dry and sunny, and, secondly, free-working sweet, loam soil which retains moisture well but has good drainage. On light soils the crop fails in a dry spell, while on very rich humus soils too much haulm growth is made without a corresponding production of seed. Heavy clay soils are unsuitable being too cold and wet in spring resulting in failure of the seed to germinate or in risk of loss from infection with root rot.

CULTIVATION: The pea crop is a valuable one in the rotation on mixed farms especially as a preparation for wheat. It may be sown at any stage in the rotation provided the field is clean and not over-rich. The crop repays thorough and deep cultivation during winter so that the soil is mellowed by frosts. Sowing should be delayed until mid-spring (October) when the soil is warm enough to ensure rapid germination.

Sowing is carried out with the combine drill at the rate of 3 to 3½ bushels per acre together with 1-2 cwt. superphosphate, the coulters being at the usual 7 in. spacing. The seed is usually dressed with a mercurial dry dressing, or cuprous oxide, as a preventive of fungous attack to which the seedling plants are very liable. When the young plants appear to be firmly established the crop is harrowed to destroy weeds and conserve moisture. If a further strike of seedling weeds appears a second harrowing may be given. Weeds with woody stems such as fat hen (*Chenopodium album*) are particularly objectionable in this crop as when dry they may damage mower knives.

ROGUEING: The crop usually flowers within two months from sowing time, and is stated by growers to benefit very considerably from light rain falling at this stage of growth. The crop is then "rogued" by experienced men who go systematically through the flowering crop on "beats" at a few paces from one another, removing all off-type plants, thus ensuring that a high standard of purity is maintained.

HARVESTING: The aim of the grower is to secure a sample which has a good green colour with the peas of even size, and wrinkled but not shrivelled. To obtain this it is important to cut at the best stage of ripeness. This may be defined as when the crop appears yellow, but while the top pods are still green, and all the seed peas are still green.

The crop is cut with the mower and after lying in the swathe for several days may either be threshed by means of a header-harvester with pick-up attachment, or be conveyed by sweeps to a stack. In some cases the grower's contract stipulates that the crop must be stacked.

Care must be taken when threshing that the seed is not cracked or split.

MACHINE-DRESSING: The crop is forwarded to the merchant's store for machine-dressing which is carried out by men experienced over many years in removing weed seeds, particles of earth, cracked or split peas and the like. Some lines are further submitted to hand-picking by girls who take out discoloured or shrivelled seed when the seed passes in front of them on a moving belt.

CERTIFICATION: Government certification of seed peas has not been considered necessary on account of the careful control, maintained by contracting merchants.

DISEASES: Several diseases collectively known as "root rot" affect the stem near the soil surface and may cause serious loss. Crops on poorly drained soils are particularly liable to be attacked. Control measures, besides the use of seed dusts above-mentioned, should be aimed at cultural practices to ensure rapid germination and vigorous growth. There are no serious insect pests of peas in New Zealand.

SELECTION AND PLANT BREEDING: Seed stocks become mixed and deteriorate very rapidly. Consequently they require careful attention to purity, and periodic renewal. The Agronomy Division undertakes the raising of pure lines of the more important commercial varieties and makes these available to merchants. Several promising lines have been developed from crosses made at the Pure Seed Station. One of these originating from the cross Greenfeast × Greatcrop is now available for distribution.

A recent article by Calder* has described the development and performance of a new blue and a new white field pea. A new boiling pea called "Mammoth Blue" has been developed by crossing Blue Prussian with Harrison's Glory. It tends to give higher yields than Blue Prussian and produces much larger and more attractive seed of equivalent cooking quality. A new white splitting pea called "White Prolific" has been developed by crossing Blue Prussian with Greenfeast. It gives higher

*R. A. CALDER. The development and performance of a new blue and a new white field pea. *N.Z.J Agri.* Vol. 65, No. 6. Dec., 1942.

yields than White Ivory and the seed quality is almost as good.

Blue peas are used for canning and packeting, and the annual consumption in Great Britain is well over 60,000 tons. Most of the pre-war supply came from Holland, Belgium, and Japan, with a small supply from Tasmania. The New Zealand Blue Prussian pea has not been particularly popular in Great Britain because of its variable hardness and slow absorption of water, both undesirable features in peas for the packet and canning trades.

White peas are used for splitting for soup purposes; it is estimated that Great Britain imported over 15,000 tons before the war, chiefly from the Continent of Europe, or from India. White peas are not grown to any great extent in New Zealand, but it is possible that the acreage devoted to them could be increased if more satisfactory types were available. It is considered that "White Prolific" may be such a type.

Dwarf Beans

Various varieties of dwarf beans are grown for seed purposes in New Zealand, but only on a small scale. The stock seed is usually imported from U.S.A.

Official investigations have been mainly directed to a study of varietal characteristics, and of disease resistance. The following varieties show some resistance to bacterial wilt (*Pseudomonas medicaginis*) Hawkesbury Wonder; Burnley selection of Canadian Wonder; Pale Dunn. A variety which has been introduced from U.S.A. is showing resistance to bean (*Phaseolus*) mosaic.

Onions

For a good many years the bulk of the onion seed required in New Zealand has been locally produced. This has been necessary as the general experience is that varieties introduced from the Northern Hemisphere frequently fail to make satisfactory bulb growth under New Zealand conditions.

A number of onion-growers and seed merchants have made selections with the object of producing a strain which would combine high yielding capacity with good keeping quality and disease resistance.

A very satisfactory strain having these characteristics now constitutes most of the commercial crops; it has been named "Pukekohe Longkeeper."

Seed is grown under Government inspection from bulbs selected from approved crops and transplanted during the winter months. Seed growing is most successful in the Marlborough and Wairarapa districts where the harvest weather is dry and sunny.

Other Crops

Other vegetable crops grown for seed include broad beans, carrots, parsnips, garden beet, silver beet, marrows, pumpkins, leeks, and tomatoes, although in most cases only part of the annual requirements are locally produced.

Seeds not grown as a rule on a commercial scale include lettuce, celery and the various garden brassica crops.

SOUTH AFRICA VEGETABLES AND ROOT CROPS

As in many other countries, war conditions have produced the need for increased production of food, and one of the results of this has been an increased demand for vegetable crops. In addition to the need to meet the demands of ordinary domestic consumption, convoys take in large quantities of vegetables at the ports and the army demand is also large. Considerable quantities are also canned and dehydrated for the use of South African troops stationed outside the Union.

Up till the outbreak of war, the vegetable seed industry in South Africa was still undeveloped; in 1939, considerable expansion became essential, and it was also desirable to gain public confidence as regards the high standard of seed produced within the country. It is stated that this stage has been passed, since the seed supplies of Boer pumpkin and Cape Spitzkool cabbage are all met from local sources, there being areas where one or other of these vegetables is grown exclusively for seed production. In addition, the Gamtoos Valley in the Cape Province has in the past 10 to 15 years become an important cauliflower seed area; pea seed is produced in the Orange River Islands near Kakamas, and onion seed in a number of districts.

The development of the vegetable seed industry in South Africa is not regarded merely as a temporary war measure, and it is being recommended that the industry should be placed on a sound basis while economic conditions are favourable. There is, for example, a surplus of onion and cauliflower seed, and it is suggested that a survey should be made of markets in neighbouring African States and overseas, in order to cater for their specific requirements, and supply them with varieties that are best adapted and give the highest yields of best quality produce.

Sufficient seed of sugar and French beans, pumpkin, peas and eggplants are produced; production of runner bean, carrot, beet, parsnip, leek, spinach, cabbage, squash and tomatoes is on the increase, but expansion is still possible. Production is insufficient as regards all root crops, lettuce and drumhead and roundhead cabbage.

It is appreciated that the production of vegetable seed is a highly specialized industry, and its intensive nature entails high costs. Most vegetable seeds are produced in sunny areas where dry climatic conditions prevail from the time of flowering until the seeds are ripe. Cauliflower and vegetables such as celery are exceptions, preferring a more humid climate.

No schemes of crop inspection or seed certification have yet been developed, and it is frequently extremely difficult to conform to the ideal requirements in view of the fact that most of the seeds have until quite recently been imported, and have not always been of the desired quality or adaptation. It is now being recommended that seed growers should use only seed grown in South Africa for their new seed production areas.

Several articles have already appeared giving hints on seed selection, cultivation practices and crop management for inexperienced growers, and the Division of Horticulture of the Department of Agriculture, as well as the appropriate Departments in the Colleges of Agriculture, are doing everything possible to place the industry on a sound basis. Selection of suitable types is also proceeding, but no seed is yet available for distribution. Any grower who possesses an outstanding variety is advised to make the best use of it for seed production. In due course, selected and bred varieties and seed control will be available to safeguard the maintenance of high quality production.

In the meantime, growers are recommended to practise a form of selection on their own, using either individual plant selection or mass selection. One of the articles under review describes the types that should be aimed at in the following groups of plants, and gives information regarding possibility of cross-pollination, time to harvest, and yields of seed that may be expected:

(a) beans, peas, brinjals (egg-plants), capsicums, tomatoes, lettuce and endive;
(b) broccoli, cabbage, cauliflower, kale and kohlrabi;
(c) carrots, beet, Swiss chard, parsnips, radishes, turnips and onions;
(d) cucurbits: pumpkins, squash, sweet melon, spaanspek, watermelon and cucumber.

A special sowing chart for use in producing vegetables in the winter rainfall area is given in *Farming in South Africa* for March, 1943. Details provided include the names of adapted varieties (see list at end of article), time of sowing, transplanting time, distances to allow between rows and between plants, depth of sowing, and the amount of seed required per row of 100 ft. or per morgen. The figures given apply, however, to the cultivation of vegetables as a crop and not for seed.

Seed of root crops such as turnip, swedes, chou-moellier and mangel has also been imported in the past, but here again self-sufficiency is now the aim. With the exception of mangels, these crops require comparatively cool growing conditions; being frost-resistant, they are treated mainly as winter crops in South Africa, except in

the winter rainfall area. Irrigation or adequate rainfall is necessary if they are to be grown successfully. Mangels, although moderately frost-resistant, prefer hot and dry conditions and are therefore regarded as a summer crop; heat may again become a limiting factor, especially if it is associated with high humidity.

The most suitable conditions for rape, kale, turnips, swedes and chou-moellier, particularly for seed production, will be found in the higher middleveld and highveld areas where the climate in late summer and early spring is comparatively cool. Mangels can be grown successfully at lower altitudes; for seed production, the middleveld and lower highveld would appear to provide an appropriate environment.

Of the several methods that may be used for the production of seed of brassicas, the following is the easiest, cheapest and most practicable under South African conditions, although it is recognized that it is not the best from the point of view of selection.

A portion of the ordinary crop is left standing through the winter to produce seed the following summer, or, in the case of rape and sometimes also kale and chou-moellier, even during the same winter. The seeds are produced in pods and when these have taken on a yellowish colour they should be picked off the plants, or the plants cut by sickles or knives and subsequently threshed by sticks or flails. Cutting of the plants is best done early in the morning while the dew is still about, as this prevents shedding of the seed. Bolters should be removed in the case of swedes and turnips, and early flowering plants of rape, kale and chou-moellier are also best removed.

Mangel seed can also be produced by the method which has just been described, but better results are obtained if the following method is used: Select fully developed plants from the existing crop and store them until spring for seed production. In selecting the plants, special attention must be given to soundness and shape of the roots.

The roots are lifted very carefully, and after removal, without injury to the crown, they are stored in a dry, well-ventilated shed where they are protected from frost. In spring, when the danger of late frosts is over, the roots are planted out in a well-prepared field. The distance between the rows should be sufficiently wide for safe cultivation, but within the rows the spacing can be fairly close. Irrigation or adequate rainfall is necessary to give the roots a good start. Planting may be done by making furrows with a suitable plough or by digging individual holes. The roots should be completely covered up with soil.

When the plants begin to send up their flowering stalks it is advisable to cut a small piece of the main shoot, as this prevents the plant from growing too tall and also encourages the growth of lateral shoots. The plants should be harvested only when the seed heads are nearly black and dry. The stems are made into bundles and then placed in small stooks in which they are allowed to dry until ready for carting and threshing.

Where a crop of mangels is left in the ground during winter with a view to seed production, as outlined in the first method for the other root crops, it is recommended that the roots should be well earthed up after all undesirable types, especially the bolters, have been removed.

Articles Used In Preparing This Note

Elden, H. van. The production of vegetable seed. *Fmg. S. Afr.* 17. pp. 425-30. July, 1942.

——————— Production of vegetable seed. *Fmg. S. Afr.* 17. pp. 807-8. Dec., 1942.

Neethling, J. H. Vegetable seed production. *Fmg. S. Afr.* 18. pp. 234-6. March, 1943.

Schultz, W. The production of root-crop seed. *Fmg. S Afr.* 17. pp. 513-4. Aug., 1942.

Vorster, P. W. A sowing chart for vegetables in the winter rainfall area. *Fmg. S. Afr.* 18. pp. 176-80. March, 1943.

Varieties of Vegetables Grown in Winter Rainfall Area

Crop	*Varieties*
Potatoes	King George, Arran Banner, Green Mountain, Dunbar Standard, Katahdin, Up-to-date.
Asparagus	Mary Washington.
Beetroot	Improved Dark Red,* Detroit,* Flat Egyptian.
Broadbeans	Broad Windsor Long Pod, Hangdown Long Pod.
Beans (Green)	Dwarf beans :—Afrikander (Victory), Long Tom, Canadian Wonder, Kudu Stringless,* Full Measure,* Tendergreen,* Refugee,* Burpee Stringless,* Chestnut Greenpod.* Butter beans :—Yellow Podded Wax, Golden Podded Wax, Mont d'Or Butter. Runner beans :—Eksteen's-runner, Morse's Pole,* Kentucky Wonder*.
Cauliflower	Southern Cross, Veitch Autumn, Giant Italian, Giant (early and late).
Egg-plant	Long Early Purple, New York Spineless.
Peas	Greenfeast,* Perfection,* Emperor,* Stomppeul, Weihahn's Crescent.*

*Good canning varieties.

Crop	*Varieties*
Cucumber	Evergreen, Early Fortune, Chicago Pickling, Zeppelin.
Cabbage	Early :—Copenhagen Market, Jersey, Wakefield. Med. early :—Spitzkool. Med. to late :—Savoy and " drum and ball head " types.
Kohl-Rabi (Turnip Cabbage)	Early White, Vienna, White Goliath.
Maize (Green mealie or Sweet corn)	Golden Early Market, Golden Bantam, Country Gentleman, Evergreen.
Vegetable marrow	Long Green Bush-marrow, Long White Bush-marrow (also vine varieties of these).
Pumpkins	Flat White " Boer ", Fraserdale " Boer ", Cape Sweet, Ceylon.
Sweet potatoes	Borrie, Witpatat, Port Natal, Rondeblaar.
Parsley	Extra-curled Double.
Leeks	Broad Flag, Giant Italian.
Radishes	Chinese Rose Winter, French Breakfast, Early Scarlet, Globe.
Turnips	American Purple Top, Starkes Express, White Stone, Early White Milan.
Chillies	Large Bell, Long Red.
Rhubarb	Victoria.
Celery	Giant Pascal, White Plume.
Salsify (Black)	Black root.
(White)	White French.
Squashes	Little Gem (trailing), Golden Custard, Scallop (stem), Golden, Hubbard (trailing), Hubbard improved, Green (trailing), Table Queen (trailing).
Lettuce	New York Special, New York Hubria, Webb's Wonder.
Sweet Melon	Rocky Ford, Hale's Best, Bay View, Cape Winter.
Spinach—Winter	Bloomsdale.
Summer	Silver Beet :—Dark Green, Luccellus, New Zealand.
Tomatoes	Bonnie Best, Rutgers, Marglobe, Marvel.
Onions	Australian Brown, Spanish Brown, Cape Straw Coloured, Early Flat Yellow, Cape (early).
Watermelon	Cape Mountain, Sweet (Cape Ice), Cream (Tom), Watson, Florida Favourite.
Parsnips	Hollow Crown, Short Sweet, Sutton's Student.
Carrots (Yellow)	Nantes, Cape Market, Chantenay.

There would appear to be two problems involved. The first is whether it is possible for those countries in the tropics which possess highlands to make themselves largely independent of supplies from Overseas by producing their own seed. The second is whether it might not perhaps be possible in countries enjoying a suitable climate to build up vegetable seed production on a sound basis whereby the British Isles could be supplied with the vegetable seed which, in normal times, is produced in and imported from countries in Southern Europe.

Extremely little has been published to throw light on these questions and that little has been of an exploratory rather than a definitive nature.

Mr. A. G. G. Hill Director of the East African Agricultural Research Station, is responsible for two short but important papers.

In the first [Hill, 1940] which is based partly on replies received in response to enquiries made on his behalf by the Imperial Bureau of Horticulture, he shows the position in 1940 in the following countries :— British Guiana, Hawaii, India, Java, Kenya, Malaya, Philippine Islands, Puerto Rico, Tanganyika, Trinidad and Uganda.

Hill concludes as follows :—" From an examination of the evidence obtained, it appears that there is no reason why seed of many European vegetables should not be successfully produced in the tropics, particularly in the highland regions.

" The replies provide no acceptable evidence for or against the belief that degeneration takes place in European vegetable varieties grown from seed produced in the tropics. Lengthy experiments would be needed to settle this point, and in the course of carrying them out it is probable that new varieties, more suited to tropical conditions, would be obtained as the result of reselection, so that some of the end-products might differ considerably from the original experimental material. The success of Indian seedsmen in producing tropical varieties of cauliflower—the most fastidious and exacting of the cabbage family—and the adaptability of the Iceberg and Mignonette varieties of lettuce to tropical conditions are a foretaste of the development that can be expected in time."

In the second [Hill, 1942] East African prospects are considered. " There is no doubt," he writes, " of our ability to produce seed of beans, peas, lettuce and tomatoes, but can we produce seed of beet, cabbage, carrot, cauliflower, parsnip, onion and turnip ?" He continues, "A good seed growing district usually has a cool sunny climate and low total annual rainfall but plenty of moisture during the growing season. Certain parts of the East African highlands would fulfil these conditions, but it is doubtful whether our temperatures are sufficiently low to stimulate flowering in some of the Brassicas, one of the most important groups of European vegetables. Again, certain crops, such as the onion, require a definite minimum length of daylight to bring them to maturity. This period varies with the variety, and although the Bombay type of onion will seed in parts of East Africa, it is doubtful whether other varieties will do so. But against these drawbacks it may be found that East Africa has certain advantages over temperate regions. For instance, it may be possible to raise seed of biennials in one year instead of the normal two. Another advantage is the practical certainty of dry harvests."

He then most usefully summarizes existing literature on seed growing in temperate climates, dealing in turn with the following vegetables :— cabbage, cauliflower, turnips, peas and beans, carrots, parsnips and celery, beet and spinach, cucurbits, onions, lettuce, tomatoes, radishes. He does not pretend that these notes will serve as a sure guide to seed growing in East Africa, " where it is almost certain that modifications of standard practice will have to be evolved."

Further he stresses the fact that seed storage problems will be different. " The methods advocated for seed storage in temperate regions are usually not applicable to the tropics, where storage pests, combined with higher temperature and humidity, create their own problems. At Amani (rainfall 77 inches) it has been found that seeds are best kept in large airtight containers with a small quantity of powdered naphthaline mixed with the seed. In the tropics really thorough drying of seed is necessary before storage, preferably in a special seed-drying oven—a pyrethrum-dryer might be modified for the purpose. Small quantities of seeds can be stored for surprisingly long periods if kept in calcium chloride desiccators in a reasonably cool place."

We are informed that no notes of value will be available on the trials at present in progress in the Highlands of Kenya before September 1943. We understand that an article on the subject is likely to appear soon after that date in the *East African Agricultural Journal.*

Some References to Articles dealing with the Growth and Seed Production of Temperate Vegetables in the Tropics.

Ba Maung, U. 1936. Onion cultivation in the Northern Circle. *Bull. Dep. Agric. Burma* 31, pp. 13. [*Hort. Abst.* 7 : 688].

British Guiana. 1935. Hints on vegetable growing. *Agric. J. Brit. Guiana,* 6 : 128–54. [*Hort. Abst.* 6 : 198].

BUNTING, B., and MILSUM, T. N. 1930. The culture of vegetables in Malaya. *Bull.* (*Gen. Ser.*) *Dep. Agric. S.S. and F.M.S.* 1, pp. 78.
DALGANO, W. T. 1936. Tomato cultivation in the Bahamas, *Trop. Agric. Trin.*, 12 : 175–6. [*Hort. Abst.* 6 : 887]
HILL, A. G. G. 1940. Can seeds of European vegetables be produced successfully in the tropics ? *E. Afr. agric. J.* 5 : 476–8.
HILL, A. G. G. 1942. Vegetable seed growing in East Africa. *E. Afr. agric. J.* 8 : 15–20. [*Hort. Abst.* 12 : 1349].
MILSUM, J. N. and GRIST, D. M. 1941. Vegetable gardening in Malaya. Malayan Planting Manual 3. pp. 206, —2. [*Hort. Abst.* 12 : 313].
OCHSE, J. J. and DE JONG, W. 1932. Europeesche Groenten. [In Dutch], Batavia. Volkslectuur, Batavia-Centrum Serie 490, 3rd. Edit., pp. 109. [Refers to cultivation, seed generally being imported].
SAN PEDRO, A. V. 1936. Influence of temperature and moisture on the viability of same vegetable seeds. *Philipp. Agriculturist* 24 : 649–55. [*Hort. Abst.* 6 : 404].
SAUNDERS, L. H. 1940. Vegetable growing in the tropics. Oxford Univ. Press, London, pp. 120, 3s. 6d. [*Hort. Abst.* 10 : 1547].
TERRA, G. J. A. 1936. Uienteelt (onion growing) in de tropen. [Dutch]. *Landbouw*, 12 : 117–32. [*Hort. Abstr.* 6 : 886].
WOOD, R. C. and other. 1936. Cauliflower cultivation in the tropics. *Trop. Agric. Trin.*, 13 : 218–20. [*Hort. Abst.* 6 : 885].

The Present Position

The position as it affects the whole of the Colonial Empire has been investigated recently by Dr. H. A. Tempany, C.M.G., C.B.E., F.I.C., Agricultural Adviser to the Secretary of State for the Colonies, and a comprehensive picture is given in his stencilled memorandum to the Colonial Advisory Council of Agriculture, Animal Health and Forestry, of November 1942, which was subsequently sent with a covering despatch to Colonial Governments by His Majesty's Secretary of State for the Colonies. Permission to reproduce this memorandum has been given to us through the courtesy of the Colonial Office, who have also given us access to further relevant information received since its issue. This we include in the form of an appendix.

As regards future supplies of vegetable seed for the British Isles there would appear to be ample evidence of the ability of such places as Malta, Palestine and Cyprus to supply satisfactory seed, provided that markets can be assured and that adequate supervision is exercised over the raising of the seed.

MEMORANDUM BY THE AGRICULTURAL ADVISER TO THE SECRETARY OF STATE FOR THE COLONIES

1. The production of seeds of European vegetables in the Colonial Empire

In December, 1941, the Committee on Agriculture of the Colonial Advisory Council of Agriculture and Animal Health considered the question of the production of seeds of European vegetables in the Colonial Empire having regard to (a) the increasing demand for such vegetables partly as a result of the growth of normal requirements and partly of the further stimulation of this demand consequent on war conditions for supply to troops and labourers ; (b) the probability that with the progress of the war increasing difficulties would be experienced in obtaining supplies of vegetable seed from the United Kingdom and the United States of America ; (c) the point that it seemed desirable that supplies of seed should be available which were acclimatized to local conditions rather than that reliance should continue to be placed entirely on importations of unacclimatized seed.

The Committee suggested that the point should be brought to the attention of Directors of Colonial Departments of Agriculture and information sought as to the possibilities of producing vegetable seed in the Dependencies, together with any information which might be available concerning particular varieties of vegetables which had shown themselves specially well suited to local conditions.

This recommendation was accepted by the Council and a letter was addressed by the Secretary of State's Agricultural Adviser to Directors of Agriculture inviting observations on the question. The replies were summarized and considered by the Council, which offered certain observations thereon, and recommended that the information and discussions should be embodied in a memorandum and transmitted to Colonial Governments.

2. General

The replies show that considerable interest in the question existed in many Dependencies. Difficulties had already been experienced in obtaining seed from the United Kingdom and while, at the time of writing, supplies were still forthcoming from the United States of America there was no guarantee that these would continue, and the matter was complicated by the question of exchange. In some Colonies efforts had been made to produce supplies of suitable seed with some success.

3. The position in the various territories

(a) West Africa

Experiments at Kumasi in the **Gold Coast** in 1940 have shown that it is easy to produce seed of tomatoes, lettuce, beans, cucurbits, egg-plant, spinach, sweet corn, and kale, but no success was obtained with other temperate vegetables. Cabbage and carrot have not been induced to flower and it is suspected that the length of day is the limiting

factor. Seed of known seed producers is being produced at Kumasi to meet the demands of the public and the Department's own extensive vegetable farms, and with careful rogueing and selection there has so far been little, if any, deterioration in the quality of the seed.

To meet the unexpectedly large demands for vegetable seed in the **Gambia** known producers of seed are being grown for this purpose. Tomatoes, (Marglobe and Sparkes Earliana—originally introduced from Burpees) and varieties of lettuce are chiefly grown. So far, no success has been obtained in producing seed of cabbage, carrot, and turnips. Very few of the commonly cultivated vegetables will set seed in **Sierra Leone,** but tomatoes, lettuce, and beans will produce viable seed, although the vigour of later generations is very considerably reduced. There are no inhabited areas of sufficient altitude to ensure the setting of seed by other vegetables. No information is available concerning the position in **Nigeria**,but it has been suggested that on the Nigerian plateau conditions may be favourable for seed production and that if the supply of seed from other sources should become difficult it might be possible to organize a seed supply centre there for the whole of West Africa.*

Considerable attention has been given in **St. Helena** to the cultivation of temperate vegetables and the production of seed and it is considered that with irrigation, the acclimatization for tropical conditions of most temperate vegetables offers considerable scope. Birds constitute the main obstacle and for many vegetables bird-proof netting is required. It is proposed to make the Experimental Station a seed-producing centre for the Island. Cabbage seed has been obtained on a small scale and gives good results. The seed of cauliflower has also been produced but this crop is very unreliable and safer crops such as kale or broccoli are encouraged. Within the last two years the Calabrese variety of broccoli has been found to be extremely successful in the Highlands. The seed is easy to raise and gives good results. The following varieties also produce seed:— Couve Tronchuda (at higher elevations), carrot (certain varieties have been found to seed if left long enough in the ground), beetroot, broad bean (at higher elevations), dwarf bean, parsnip, lettuce, radish, tomato, leek, and onion.

(b) East Africa

In the highland regions of the East African territories conditions are naturally favourable for vegetable seed raising and the production of certain classes of vegetable seeds in **Kenya** has received attention for some time past. Immediately prior to the war, commercial experiments were set on foot to test the possibility of raising seed of varieties of green pea with a view to establishing an export trade. The experiments showed promise and some small experimental shipments were made. This work has, however, been discontinued owing to war conditions.

More recently the question has attained added importance owing to the demand for large quantities of vegetables, both for direct supply to military forces and also to meet the needs of the dried vegetable factory which has been established by the Department of Agriculture. Conditions are such that over large areas ordinary varieties of temperate vegetables will set seed on as large a scale as is practicable, although it is considered that developments must be gradual.

Certain vegetables, such as lettuce and tomato, seed well in **Uganda,** but others, such as cabbage and cauliflowers, do not appear to seed. Owing to the increasing demand for vegetables it is proposed to make a small start in seed production in Kigezi and Bugishu, as it is possible that some of the vegetables which will not seed in the lower altitudes will do so in the hills.

In the Northern Province of **Tanganyika,** a number of planters are engaged on the production of carrot, cauliflower, cabbage, and other seeds as well as of seed beans and onions.

Successful attempts to produce vegetable seed have been made in **Nyasaland,** and the Department of Agriculture has now undertaken the propagation of seed at the Mlanje Experiment Station. It would appear that vegetables will seed freely in certain conditions in Nyasaland; lettuce, tomato, beans, peas, and cucumbers have the widest range, while cabbage, cauliflower, onions, radish, beetroot, and carrots require specially favourable conditions. Locally produced seed of several varieties of temperate vegetables is offered for sale by the Nutrition Unit in Nyasaland.

Under **Zanzibar** conditions, cabbage, cauliflower, carrots, and onions do not set seed, but certain varieties of beans, tomatoes, lettuces, and peas seed reasonably well.

(c) Eastern

In **Ceylon,** in anticipation of the difficulty of obtaining imported supplies of seed during the war, a station at an elevation of 6,000 feet has been established for raising seed of vegetables which do not flower freely at lower elevations, and a certain amount of success has been achieved on an experimental scale. The question of advancing from the experimental to the commercial stage of seed production, so that Ceylon may be at least partially independent of outside sources of supply of seed of temperate vegetables, is at present being considered. Seed of cauliflower, carrot, peas, broad beans, marrow, and New

*For further notes see Appendix 2 (A)

Zealand spinach have been successfully produced at 6,000 feet; lettuce and carrot seed have been produced at a station at sea level, and radish at a station at 1,200 feet. The production of seed of cabbage and brussels sprouts is not being attempted, as these vegetables can be satisfactorily propagated from cuttings.

In **Malaya,** up to the time of the Japanese occupation, seeds of temperate vegetables were mainly imported, but Chinese gardeners regularly practised the raising of seed of certain vegetables, and such seed could be obtained in the markets. Conditions in the highlands in the centre of the peninsula should be favourable to the raising of seed of a number of temperate vegetables.

Mauritius is fortunate in that a number of temperate vegetables are acclimatized in the Island and are grown from locally produced seed. These include cauliflower, lettuce, onion, peas, French beans, tomato, and turnip. Seed of cabbage is not produced locally, but a variety known as "Chou Drageon" is propagated by cuttings and grows well at altitudes of 1,000 feet and over. Cauliflower seed has been maintained from year to year for over 25 years from the varieties "Alger" and "Le Normand" originally introduced from France. It is possible that the present varieties are local strains which have evolved from the originals. An abundant supply of seed of tropical vegetables is available.

(d) Mediterranean

Malta* farmers have always been able to raise their own supplies of seed, but beet and carrot seed have to be renewed from abroad every three or four years. To increase the seed supply, the production of vegetable seeds is being carried out in the Public Gardens which are widely scattered throughout the Island. Attempts are being made to produce seed of turnips, kale, and carrots, and it is believed that local requirements of these seeds, tomato, and possibly cabbage and broccoli, could be produced.

Cyprus experiences no difficulty in raising its own supplies of vegetable seeds and even before the war importations of seed were negligible. In **Palestine,**† seed has been produced, in a small way, of every important temperate vegetable except cabbage. It is hoped that during the present year cabbage seed will also be produced. While at present dependent on appreciable imports of vegetable seeds, there are good prospects that Palestine will be able to produce all its requirements in the course of another year. An immediate start is being made to raise the necessary seed for the production of vegetables for the Forces.

*For further notes see Appendix 2 (B).
† ,, ,, ,, see ,, 2 (C).
‡ ,, ,, ,, see ,, 2 (D).

(e) West Indies and West Atlantic

The possibility of producing seeds in **Bermuda** is being investigated as a precaution against any interruption in importing supplies, which have so far been obtained with little or no difficulty. Types which can be produced locally include beans, cucurbits, tomatoes, egg-plant, and sweet pepper. Trials are being started in **Jamaica**‡ in the hills, as it is thought that at lower altitudes varieties would lose vigour rapidly. The trials will include Early Patna cauliflower.

It is proposed in **Barbados** to try to produce seed of cabbage, beet, onions, cauliflower, and lettuce and to test the locally produced seed against imported seed.

The production of seed of temperate vegetables has been tried in **British Honduras** but so far with disappointing results. Some success was obtained with Sutton's Indian Early Market and Early Patna cauliflowers, but generally the seed set is not viable. In one place, Mignonette and Grand Rapids lettuce set good seed, but generally the set of viable seed is unreliable. As in most Colonies, seed of tomatoes is easily produced. Experience in **British Guiana** has been that annuals such as lettuce and tomatoes produce viable seed quite readily, but the progeny after the first or second generation degenerates in both the size and quality of the product. Seed production by biennials is uncertain but the question has been little studied. Experienced gardeners always prefer to bring in fresh seed annually.

4. Discussion

It is clear that in many Dependencies conditions are favourable to the production of vegetable seeds and there is no obvious physical obstacle to large scale production. Conditions are most favourable in the more elevated areas although seed production of some vegetables appears to be possible even at sea level. The possibilities are shown, for example, in Mauritius, where strains of many vegetables acclimatized to local conditions have been evolved by Indian market gardeners, and it seems highly probable that by the application of modern methods of selection and propagation further developments should be easy. Moreover, substitution of local for imported supplies of seed would obviate the risk which undeniably exists of introducing plant diseases through the medium of imported seed.

Hitherto, seed supplies have been mainly obtained from the United Kingdom and the United States of America, and in the case of the African and Eastern Colonies to some extent from South Africa and India. A considerable amount of information has been accumulated concerning seedsmen's varieties of vegetables suited to different local conditions and this has been sum-

marised in Appendix I. There is a general opinion that, with some exceptions, varieties of vegetables produced in the United States of America and particularly the Southern States, and also in South Africa and India, are better suited to Colonial conditions than those coming from European countries. This is easily possible since conditions there approximate much more closely to those in the Colonial Dependencies than do those of Northern Europe and the northern parts of the United States. This, however, appears to constitute an additional argument in favour of endeavouring to expand the production of vegetable seed in the Dependencies themselves, since the varieties in question are produced not with a view to their cultivation in the tropics but in the areas of production, and their suitability to conditions in the Colonial Dependencies is at best fortuitous.

No doubt the principal reason for the existing state of affairs is that in the Colonial Dependencies there are no large commercial organizations interested in the development of local seed supplies. The Departments of Agriculture, which in the absence of such commercial firms are the only bodies which could take the question up, have in most cases been preoccupied with other questions, and have been able to devote but little attention to the matter. Consequently, where local strains of seed exist it is largely the result of the unaided efforts of local market gardeners. Moreover, the importation of seeds has in many Dependencies largely lain in the hands of mercantile firms and it is clearly to their interest that the position should remain unchanged.

The opinion in a number of Dependencies, particularly in the West Indies, is that dependence on imported supplies of seed is under normal conditions likely to continue. With the progress of the war, however, and the increasing shortages of shipping and seed supplies, it seems not unlikely that the immediate difficulties may become so great that it will be impossible to continue to place reliance on supplies from overseas. Consequently, many Dependencies will probably be forced to fall back on local supplies, if vegetable production is to be maintained. In this event, systematic organization of the production will become imperative if supplies of vegetables are to be maintained, and in these circumstances it would seem that there may be immediate need for effecting a development which may be of permanent value in the post-war period.

In some Dependencies, indeed, a forward policy in this direction has been already advocated. Thus in Malta the suggestion has been made that the island might become a centre of seed supply for other Mediterranean territories. A somewhat similar suggestion has been made for inauguration in Nigeria of a centre of supply for the whole of British West Africa. In East Africa, the question of seed raising has been discussed by the Director of the East African Agricultural Research Station in a recent article in the East African Agricultural Journal, which contains much useful information and many suggestions of practical value, and recent information suggests that the Government of Kenya may be considering the development of seed production on some scale.

It is clear that the initiative must lie in the first place with the Departments of Agriculture, but once the initial stages have been passed there does not appear to be any reason why the raising of seed for distribution should not be undertaken by private enterprise working in collaboration with the Departments, and subject to the proviso that this must be strictly supervised to ensure the maintenance of the purity and quality of the supplies. In this connexion attention may be called to the very great progress made in Great Britain in ensuring supplies of pure, viable seed as a result of the passing of the Seeds Act of 1920, (10, and 11 Geo. 5. CH.54). The development of the commercial raising of seed in the Colonial Dependencies would probably necessitate legislation on similar lines, which should be envisaged at an early stage.

It might be worth considering the possibility of taking advantage of the fact that in certain Dependencies, e.g., Mauritius or Cyprus, the raising of seed has for long been practised by market gardeners, and locally acclimatized seed of vegetables exists, by introducing supplies of these to other areas, where they could serve as a basis for further selection. Obviously, also, efforts should be made to acclimatize seed of American and European varieties which are known from experience to be suited to cultivation in the Colonial Dependencies.

A point that has appeared in a number of replies is the belief that locally raised seed tends to degenerate from year to year with continuous cultivation. Although the opinions were variable, and to an extent conflicting, the effect where it is said to exist is usually attributed to climate, but there is no positive direct evidence that this is the case, and it is suggested that the matter requires careful and systematic investigation. It may be possible that the effect is really the result of absence of selection and of uncontrolled crossing in the field; on the other hand it may also be due to some undetected disease factor or a combination of the two. It may also of course be that length of day influences the question, and investigation of this point is also needed. In any case, it should not be beyond the ability of the plant breeder to elucidate the factors operating and to indicate means by which the difficulties could be overcome. It should, however, be emphasized that the matter requires careful and systematic study.

Another factor of importance are the condi-

tions under which seed is stored for propagation from one season to another, since, unless storage conditions are suitable, seed rapidly deteriorates and loses viability. It has been suggested in some quarters that storage at low temperatures is necessary, but doubts have been expressed whether this is really essential; it has also been suggested that there may be some association of ideas and that, as with deterioration on repeated cultivation, so with storage, the fact that these plants are natives of temperate countries has engendered the belief that storage at low temperature is essential.

It is believed, however, that maintaining seed at low temperatures is not by itself a sufficient provision to ensure their satisfactory storage and to maintain viability, although it is not improbable that subjection of seed to a low temperature before planting so as to induce vernalization may improve growth. This point requires further investigation under Colonial conditions.

It is however clear that successful storage of seed is dependent on the moisture content before storage being reduced to a sufficiently low value. Experience with cotton seed indicates that if the moisture content is reduced below 8 per cent and the seed kept in a dry atmosphere it will retain its viability for several years.

Other observations indicate that the optimum conditions for the storage of seed are obtained when both temperature and humidity are maintained at a low and constant level. Wide fluctuations of either factor should be avoided. Seeds that have been dried and kept in sealed containers, or prevented in some way from taking up moisture from the atmosphere, can be stored for long periods even at high temperatures. The ripeness, maturation, moisture percentage, and freedom from damage and disease are of fundamental importance in determining the longevity in storage. Given sound and clean seed, moisture percentage appears to be the decisive factor. Methods of drying particular types of seed require investigation, and it is not improbable that different species will require different treatment.

Seed also requires to be protected from the attacks of weevils and other boring insects which will destroy their power of germination. This can be done by storing seed in air-tight containers from which insects can be excluded, although owing to the fact that living seeds respire, though very gently, very prolonged continued storage under air tight conditions might possibly lead to injurious accumulations of carbon dioxide. The fumigation of seed with carbon bisulphide is effective in controlling infection by insects, while naphthalene balls placed in the receptacle containing stored seed is a satisfactory preventive against insect attack. The use of certain insecticidal dusts may also be worth considering.

APPENDIX I.

List of varieties of vegetables which have been successfully grown in Dependencies.

N.B.—.The information given in brackets below refers to the season when grown e.g. (Winter), habit of vegetable (climbing), origin of seed (South Africa) or seedsman (Burpee). Of the 14 seed firms mentioned, 7 are in U.S.A., 2 in S. Africa, 2 in England, 1 in the Canary Isles, 1 in Scotland and 1 in India. Their addresses can be obtained from the Bureaux.

BEANS AND PEAS

DWARF AND RUNNER BEANS (STRING, POLE, SALAD BEANS) :—

Amani : Canadian Wonder (dwarf) and climbers Epicure Abundance (South Africa), and No. 1251 (Arusha).*

Barbados : Bountiful (dwarf) and Old Homestead (climber) (Henderson).

Bermuda : (Winter) Bountiful.

British Guiana : Kentucky Wonder, Yard Bean, Waby Bean, and Bonavist.

British Honduras : Kentucky Wonder (Burpee) and Bountiful.

Gold Coast : Dwarf Plentiful (Sutton), Premier (dwarf) (Sutton), Bountiful (dwarf) (Starke-Ayres), Earliest of All (climbing) (Sutton), Alabama Nos. 1, 8, and 25 (climbing) (U.S.A.).

Leeward Islands—Montserrat : Bountiful.

Sierra Leone : Canadian Wonder, Premier and Dwarf French Sugar (Sutton), Early Valentine Red, Kentucky Wonder, Kentucky Pole, New Macaslan Pole and Refugee Bush (Hastings), New Dwarf French (Ryder), Everbearing (Kirchoff).

St. Helena : White Haricot, Red Canadian Wonder.

Trinidad : **(I.C.T.A.)** : Kentucky Wonder (Maule).

Windward Islands—Dominica : Bountiful.

Zanzibar : Canadian Wonder (Nairobi), Pole Runner (South Africa), Victory (South Africa), White Haricot (Nairobi)—the last three in the period March-October.

LIMA BEANS :—

Barbados : Ideal (Henderson).

Bermuda : (Summer) Bush Lima, Fordhook, Leviathan.

British Guiana : Lima No. 3, Bush Lima (Henderson).

Gold Coast : American Dwarf.

Trinidad : **(I.C.T.A.)** : King of the Garden (Maule).

PEAS :—

Amani : Senator in the cool season and Mauritius at other times.

Bermuda : (Winter) Little Marvel, Laxton's Progress and Morse's Market.

*See " List of Food Crop Varieties Available for Distribution " East African Agricultural Research Station, Amani, 2nd. ed., Jan. 1942.

Ceylon: English Wonder.
Gold Coast: Duchess of York (Sutton), Productive Marrowfat (Sutton).
Mauritius: A local strain (white or purple flowered), originally introduced from India, known as "Petits pois creole," "Petits pigeon," or "Petits pois martin", grows well all the year round in the uplands.
St. Helena: Stratagem, Giant Stride, Little Marvel.
Zanzibar: (March–October) Alderman (Nairobi), Mauritius (Mauritius).

COWPEA OR BLACKEYE PEA (*Vigna spp.*) See "Some Indigenous or Acclimatized Vegetables" below.

SEED PRODUCTION

Victory, Long Tom, and Canadian Wonder beans seed reasonably well in Zanzibar, and Alderman and Mauritius peas are also reported to produce seed there. In the Gold Coast, seed is being successfully produced of the recommended varieties of dwarf, climbing, and Lima beans. In Ceylon, seed of acclimatized Nuwera Eliya broad bean and of English Wonder pea have been successfully produced at an elevation of 6,000 ft. Seed of many varieties of French beans and of the local strain of peas is produced in Mauritius. The beans grown in Sierra Leone will produce viable seed, but it is stated that the vigour of later generations is very considerably reduced, and the resulting plants unsatisfactory.

Seed of King of the Garden Lima bean can be produced in Trinidad, but it is recommended that it is better in the long run to import seed annually. The varieties of beans grown in Bermuda and Barbados will produce seed without difficulty, and varieties of string and Lima beans have been grown from locally produced seed in British Honduras.

CABBAGE, CAULIFLOWER, BRUSSELS SPROUTS

CABBAGE:—

Amani: Ellam's Early, most early varieties are successful.
Barbados: Danish Ball Head and Late Flat Dutch (Henderson), Pride of India (Sutton, India).
Bermuda: (Summer) Green Glazed, (Winter) Copenhagen Market, Goldenacre, Charleston Wakefield.
British Guaina: Centennial Late (Hastings), Flat Dutch (Hastings), Succession (Henderson), Foremost (Sutton).
British Honduras: Early Flat Dutch (Burpee), Jersey Wakefield (Burpee and Henderson), Copenhagen (Henderson).
Ceylon: Earliest of All, Early Drumhead, Largest Solid Drumhead, and Red Drumhead have been found suitable for the drier parts of the low country.
Gold Coast: Pride of the Market (Sutton), Selected Drumhead (Sutton), Improved Winnigstadt (Sutton), Premium Flat Dutch (Burpee).
Leeward Islands—Montserrat: Succession.
Mauritius: Chou Drageon (does well at 1,000 ft. or over).
Nyasaland: Champion Ox (Kirchoff), Surehead (Kirchoff).
St. Helena: Early Drumhead, Copenhagen Market.
Sierra Leone: Savoy Drumhead, Early Market, Earliest, and Earliest of All Savoy (Sutton), Selected Drumhead, and Summer Drumhead (Dobbie), Steins Early Flat Dutch, and All Season (Hastings), Brunswick, and Spitzkool (Kirchoff).
Trinidad (I.C.T.A.): Jersey Wakefield (Maule).
Windward Islands—Dominica: Succession.
Zanzibar: (March–October) Succession (U.S.A.), Mammoth (South Africa), Prize Drumhead (South Africa), Pride of India (Nairobi), and Drumhead (Nairobi).

CAULIFLOWER:— (with the exception of Alger and Le Normand the varieties tested are Sutton's, India).
Amani: Early Market.
Barbados: Early Patna, Early Market.
British Guiana: Early Benares (an outstanding variety), Maincrop Benares, Maincrop Patna, Early Patna.
British Honduras: Early Market, Early Patna.
Ceylon: Early Patna and Late Patna have been found suitable for the drier parts of the low country.
Gold Coast: Early Patna, Early Market.
Leeward Islands—Montserrat: Early Patna.
Mauritius: Alger and Le Normand. Cauliflowers thrive only at altitudes of over 1,000 ft.
Sierra Leone: All the Year Round and Early Patna (Sutton).
Trinidad (I.C.T.A.): Early Patna.
Windward Islands—Dominica: Early Patna.
Zanzibar: (March–October) Early Market, Early Benares Early Patna.

BRUSSELS SPROUTS:—

Gold Coast: Dwarf Gem (Sutton).

SEED PRODUCTION.

Generally at low elevations in the tropics the seeding of temperate biennials is apparently uncertain but seed production may be possible under special conditions. Seed of cabbage and cauliflower is being produced in the Northern Province of Tanganyika and in Nyasaland. It is believed that it would be possible to produce cauliflower seed at higher altitudes in several Dependencies. Neither cabbage nor cauliflower have seeded in Zanzibar nor at the Imperial College of Tropical Agriculture, and although some success was obtained in British Honduras with Early Market and Early Patna cauliflower the seed set was frequently not viable. Cauliflower seed is produced in Mauritius, and Sutton's Early Giant cauliflower at an elevation of 6,000 ft. in Ceylon. It is interesting to note that in several places cabbages, cauliflowers, and brussels sprouts are not grown from seed but from shoots taken from the stems of old plants.

OTHER CRUCIFERAE

KOHL-RABI:—

Barbados: Extra Early White Vienna (Henderson).
British Guiana: Early White (Sutton).

British Honduras : White Vienna (Steckler).
Gold Coast : Earliest White (Sutton), Earliest Purple (Sutton), Early White Vienna (Starke-Ayres).
St. Helena : Early White Vienna.
Sierra Leone : Purple Vienna (Kirchoff).
Zanzibar : (March–October) Large Green (Nairobi).

CHINESE CABBAGE :—

Bermuda : (Summer) Chi-hi-li.
Trinidad (I.C.T.A.) : Pe-tsai (Maule).

TURNIP :—

Barbados : Purple Top White Globe and Golden Ball (Henderson).
Bermuda : (Winter) Purple Top White Globe.
British Honduras : White Flat Dutch (Steckler), Purple Top Milan (Steckler).
Gold Coast : Early Snowball (Sutton).
Leeward Islands—Montserrat : Golden Ball.
Mauritius : A local strain.
Nyasaland : Champion Swede (Kirchoff).
St. Helena : Snowball.
Sierra Leone : Snowball (Sutton), Red Top White Globe (Kirchoff).
Trinidad (I.C.T.A.) : Purple Top White Globe (Maule).
Zanzibar : (March–October) Early Snowball (Nairobi), Purple Top White Globe (Nairobi).

SEED PRODUCTION

Seed of Chinese cabbage and turnip is produced in Mauritius and of swedes (Champion) in Nyasaland. Seedof Chinese cabbage can be produced at the Imperial College of Tropical Agriculture.

SALAD VEGETABLES

LETTUCE :—

Amani : (hot season) Iceberg, Mignonette ; (cool) Tom Thumb.
Barbados : Mignonette and Black-seeded Simpson (Henderson).
Bermuda : (Winter), Big Boston, Imperial 44, Mignonette.
British Guiana : Mignonette (Henderson), Mignonette (Hastings), Green Mignonette (Ferry Morse).
British Honduras : Mignonette (Burpee), Mignonette (Henderson), Florida Iceberg (Burpee), Grand Rapids.
Ceylon : Paris White, Iceberg have been found suitable for the drier parts of the low country.
Gold Coast : Cabbage type—A1 (Sutton), Supreme (Sutton), Black-seeded Simpson (Sutton), New York Special (Starke-Ayres), Lemon Queen (Dobbie), Immensity (Kirchoff) ; Cos—Little Gem (Sutton).
Mauritius : Mignonette.
Nyasaland : Cabbage (Kirchoff), Little Gem (Kirchoff).
Leeward Islands—Montserrat : Mignonette.
Sierra Leone : Golden Ball, A1 Cabbage Lettuce, All the Year Round, and Paris White Cos (Sutton), Exhibition and Ben Lomond (Dobbie), Drumhead White Cabbage, Iceberg, Mignonette and Big Boston (Hastings), New York, Iceberg and London White Cos (Kirchoff).
Trinidad (I.C.T.A.) : Mignonette (Henderson), Crisp-as-Ice (Maule), Iceberg (Maule).
Uganda : (Kampala neighbourhood) New York, Iceberg.
Windward Islands—Dominica : Mignonette.
Zanzibar : Mignonette (U.S.A.), Early Paris Market (Nairobi), Immensity (South Africa), Mammoth Butter (South Africa).

RADISH :—

Barbados : Icicle and White Tipped Scarlet Turnip (Henderson).
British Honduras : Crimson Giant (Maule), French Breakfast (Steckler).
Ceylon : Acclimatized Matale has been found suitable for the drier parts of the low country.
Gold Coast : Early Rose (Sutton), Early Red Globe (Sutton), White Turnip (Sutton), Red White Tipped (Sutton), Long Scarlet (Sutton), Early Scarlet Globe (Starke-Ayres).
Nyasaland : Giant (Kirchoff).
Sierra Leone : Long Red, Forcing French Breakfast, and Scarlet Globe (Sutton), Long Cardinal (Ryder), Giant Globe (Kirchoff).
Trinidad (I.C.T.A.) : Scarlet Globe (Henderson).
Windward Islands—Dominica : Crimson Giant.
Zanzibar : Scarlet Gem (Nairobi), French Breakfast (Nairobi).

TOMATOES :—

Amani : Sunrise (Sutton), Marglobe, Stone.
Bermuda : (Summer) Bonny Best, Marglobe.
Barbados : Marglobe (Henderson).
British Guiana : Brimmer (Hastings), Early Market (Sutton), Marglobe (Henderson), Crimson Cushion* (Henderson).
British Honduras : Ponderosa (Burpee) , Marglobe (Burpee) Norton.
Gold Coast : Best of All (Sutton), Bonnie Best (Sutton, India), Rutgers (Starke-Ayres), Victor, John Baer, Bay State (Three U.S. varieties).
Leeward Islands—Montserrat : Marglobe.
Mauritius : A strain of tomato with smaller and more acid fruits known as " Pomme d'Amour " is naturalized in the Island and cultivated all the year round, chiefly in the drier districts.
Nyasaland : Beauty (Kirchoff).
St. Helena : Carter's Sunrise, Early Red, Ailsa Craig, Vides' Recruit.
Sierra Leone : Klondine Red, Early Market, Best of All and Majestic (Sutton), Caledonia and Essex Wonder (Dobbie), Super Marglobe, Marglobe, Brimmer and Break O'Day (Hastings), Pritchard (Kirchoff).
Trinidad (I.C.T.A.) : Bonny Best (Henderson), Marglobe (Henderson) Winsall (Henderson).

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*For large fruits of the Ponderosa type.

Uganda : Sunrise.
Windward Islands—Dominica : Marglobe, Ponderosa.
Zanzibar : (March–October) Ponderosa (South Africa), Early Market (Sutton), Marglobe (U.S.A.), Golden Queen (South Africa), Ailsa Craig (Nairobi).

CRESS :—

Gold Coast : Plain (Sutton), Curled (Starke-Ayres).

SEED PRODUCTION.

Seed of Mignonette lettuce has been produced in Trinidad, British Honduras, Barbados, Mauritius, and Zanzibar. This variety is reported to seed freely in Zanzibar ; in British Honduras the set of viable seed was unreliable. Lettuce seed has also been produced in Ceylon, Nyasaland, and Sierra Leone. Viable seed of tomatoes is fairly readily obtained. Radish seed has been produced in Nyasaland, and at an elevation of 1,200 ft. in Ceylon.

ONIONS

Amani : Red Bombay is reported to grow well on Kilimanjaro where the photoperiod is about equal to that at Amani.
Barbados : Crystal White Wax (Henderson).
Bermuda : (Winter) Yellow Bermuda.
British Guiana : Yellow Bermuda (Hastings), Silver Skin (Hastings); the former is more suited to local requirements and tastes, Silver Skin being more of a leek type.
British Honduras : Red Creole (Steckler).
Gold Coast : Tropical (Sutton), Brown Globe (Sutton), Mammoth Red Globe (Kirchoff) and Early Flat, Yellow Cape, Yellow Bermuda (Starke-Ayres).
Leeward Islands—Montserrat : Yellow Bermuda and Crystal White Wax (Teneriffe or U.S.) Red Bombay (shallot type).
Mauritius : An Indian strain.
Nyasaland : Prize-taker (Kirchoff).
St. Helena : Yellow Bermuda is usually grown by specialist growers, but recent trials have shown that the variety Cape Flat from South Africa is a most reliable cropper.
Sierra Leone : Red or White (Teneriffe), Australian Brown (Kirchoff), and Yellow Bermuda (Hastings).
Trinidad (I.C.T.A.) : Yellow Bermuda (Prieto).
Windward Islands—Dominica : White, yellow, and red Bermuda (Teneriffe).
Zanzibar : (March–October) Bermuda (Teneriffe), Madeira (Amani).

In his " Report on the Development of Agriculture in the Bahamas," E. A. McCallan draws attention to experimental work in Virginia on the effect of length of day on bulb formation, which showed that Yellow Bermuda, White Creole, and early Grano required a photoperiod of 12 hours ; California Early Red, Yellow Strasburg, Ebenezer, and Yellow Danvers Flat required 13 hours, and that in the 13½ hours group were Australian Brown, Early Yellow Globe, Mountain Danvers, Ohio Yellow Globe, White Portugal, Southport Yellow Globe, and Sweet Spanish. McCallan recommends California-grown onion seed ; he states that the Bermuda onion is not a good keeper and this fact is also reported from other Dependencies, but it is understood that thorough drying will very considerably improve the keeping qualities.

SEED PRODUCTION.

Viable onion seed is apparently seldom set although Prize-taker produced seed in Nyasaland, and Red Creole set seed in British Honduras but the germination was poor; in Mauritius, however, an Indian variety of onions has been acclimatized and seed from it is regularly produced.

MISCELLANEOUS VEGETABLES

CARROT :—

Amani : Early Short Horn.
Barbados : Danvers Half Long and Chantenay (Henderson).
Bermuda : (Winter) Danvers Half Long.
British Guiana : Early Gem (Sutton) Intermediate (Henderson).
British Honduras : Ox Heart (Burpee) Chantenay (Burpee).
Ceylon : Danvers, St. Valery, and Long Orange have been found suitable for the drier parts of the low country.
Gold Coast : Early Gem, New Intermediate Red, and Champion Scarlet Horn (Sutton), Early Cape Market, and Chantenay (Starke-Ayres).
Leeward Islands—Montserrat : Chantenay.
Nyasaland : Chantenay (Kirchoff), Nantes (Kirchoff).
St. Helena : Early Nantes, Chantenay.
Sierra Leone : Scarlet Horn and Early Gem (Sutton).
Trinidad (I.C.T.A.) : Chantenay or Model (Maule), Danvers Half Long (Maule).
Windward Islands—Dominica : Ox Heart.
Zanzibar : (March–October) French Short Horn (Nairobi).

BEETROOT :—

Amani : Crimson Globe.
Barbados : Detroit Dark Red (Henderson).
Bermuda : (Winter) Detroit Dark Red.
British Guiana : Globe (Sutton).
British Honduras : Early Wonder (Burpee).
Ceylon : Crosby's Egyptian, Early Wonder, and Crimson Globe have been found suitable for the drier parts of the low country.
Gold Coast : Globe (Sutton), Improved Dark Red (Starke-Ayres.)
St. Helena : Crimson Globe.
Trinidad (I.C.T.A.) : Dark Red Egyptian (Maule), Detroit Dark Red (Maule).
Windward Islands—Dominica : Crimson Globe.
Zanzibar : (March–October) Crimson Globe (Nairobi), Egyptian (Nairobi), Silver Swiss Chard (South Africa).

CELERY :—

Barbados : Perfected White Plume (Henderson).
Bermuda : (Winter) Golden Self Blanching.
Gold Coast : White Gem (Sutton).
Trinidad (I.C.T.A.) : Golden Plume (Henderson).

PARSLEY :—

Gold Coast : Imperial Curled (Sutton).
Trinidad (I.C.T.A.) : Double Curled (Henderson).
Windward Islands—Dominica : Champion Moss Curled.

MARROW :—

Gold Coast : White Bush, Long Green (Sutton), Long Green Bush (Starke-Ayres).

MELON :—

British Guiana : Augusta, Rattlesnake, Dixie Queen (Hastings).
Gold Coast : Early Mildew Resister (Starke-Ayres).
Nyasaland : Klekley's Sweet.

SEED PRODUCTION.

Carrot seed of the variety Long Orange is reported to be produced in Ceylon at sea-level; carrot seed is also produced in Tanganyika and Barbados; beetroot and carrot seed are produced in Nyasaland.

SOME INDIGENOUS OR ACCLIMATIZED VEGETABLES*

SWEET CORN :—

British Guiana : Alamada Sweet (Ferry Morse).
Gold Coast : U.S.D.A. 34.
Zanzibar : (March-October) Stowell's Evergreen (South Africa), Burlington Hybrid (South Africa).

CUCUMBER :—

Barbados : Barbados (locally produced seed).
Bermuda : (Summer) A and C, Early White Spine.
British Guiana : Straight 8 (Ferry Morse).
Gold Coast : White Gem, Long Green, Prolific, Every Day (Sutton), New Model (Starke-Ayres).
Nyasaland : Bangalore.
Windward Islands—Dominica : Early Fortune.

SOLANUM MELONGENA (*Brinjal, egg-plant*) :—

Bermuda : (Summer) New York, Black Beauty, New Hampshire Hybrid.
British Guiana : Black Beauty (Henderson).
British Honduras : Black Beauty (Steckler), Indian Long Purple (Sutton).
Gold Coast : Long Purple (Sutton).
Leeward Islands—Montserrat : Black Beauty.
Trinidad (I.C.T.A.) : Black Beauty (Maule).
Windward Islands—Dominica : Black Beauty.
Zanzibar : Improved (Sutton).

HIBISCUS ESCULENTUS (*Okra— Lady's Fingers*) :—

Bermuda : (Summer) Long Green.

COWPEA OR BLACKEYE PEA (Vigna spp) :—

Windward Islands—St. Lucia : Dixie Queen, Extra Early Ramshorn, California Blackeye (U.S.).

SEED PRODUCTION.

Seed production of the above vegetables should present little difficulty.

*Attention may be drawn to the considerable amount of work carried out on certain indigenous vegetables in Ceylon. Some of this is described in *Tropical Agriculturist*, Vol. XCV, 3, Sept., 1940, in an article "Vegetable Variety Trials at Matale, Tahbowa and Karadiyanaru, 1937-40." The trials covered *Hibiscus esculentus*, egg-plant, capsicum, cowpea, cucumber, gourds, luffa and tomato. In the Gold Coast, also, selection work has resulted in considerable improvement of local strains of tomatoes, egg-plant, okra, pumpkin, squash, beans, cowpea, and peppers.

APPENDIX 2.

(A) Nigerian Plateau.

The following information from the Nigerian Government received in March 1943 supports the view that conditions may be favourable on the Nigerian Plateau. The gist of it is as follows :—

The main experimental work on the production of European vegetable seeds in Nigeria is being carried out at the Government Agricultural Station at Riyom on the Plateau. The position at present is that seeds of the following vegetables can be produced without difficulty :— Peas, beans, tomatoes, lettuce, cucurbits, sweet corn, sweet peppers, onions, radish and egg plant.

No success has yet been obtained with the following : —Carrot, cabbage, cauliflower, swede, leek, beet and parsley, but experimental work is still in progress.

The Director of Food Production and Supply, Nigeria, does not see any reason why the Plateau and other selected areas in Nigeria should not be able to supply other West African Colonies with seeds of most of the varieties of vegetables listed, with a few exceptions, notably cabbage, cauliflower and carrot. He points out, however, that in order to produce such seed in quantity the evolution of a successful technique is essential and that this would take some time.

(B) Malta.

Information recently received indicates the possibilities and the difficulties involved in seed production in Malta.

Thus the possibility of raising seed of almost all the required vegetables is shown by the fact that most Maltese farmers save their own seed of the following crops :— cabbage, cauliflower, kohl rabi, onions, carrots, beetroot,

lettuce, peas, beans, radish, parsley, spinach, tomato, marrow, melon and pumpkin and to a lesser extent celery, endive, chicory and sweet fennel. It may be noted that irrigation is necessary for all seed crops in Malta except peas, beans and probably onions.

Further at the Experimental Farm small areas were successfully devoted in 1942 to the raising of seed of lettuce, onion, radish, marrow, spinach, carrot, dwarf bean, endive, parsley, sweet fennel and sunflowers and except for carrot and bean, there were useful surpluses available for seed. Other seed produced included chick peas, broad beans and peas, most of it being suitable for sowing.

Moreover the island produces some 6 strains of early and late cauliflowers which have been kept true to type for many years.

On the other hand weeds abound, and the presence in great quantity of wild carrot, cabbage, radish, spinach, parsley and fennel are not conducive to the production of seed true to name. Further, methods of production would appear to be somewhat haphazard and isolation beyond 100 yards to be exceptional. Marrow stocks moreover contain a high proportion of virus.

It would appear, then, that almost anything can be grown for seed and that the present absence of Italian and French competition might offer an opportunity for establishing a profitable seed production industry in the Maltese Islands. But this could only be done by subjecting such an industry to strict regulation so that different strains would by isolation be kept free from danger of cross-pollination.

(C) Palestine.

Further information from Palestine shows that considerable progress has been made in vegetable seed production and that following a most successful season in 1942 it was found possible, after freezing Palestine's requirements till August 1943, to export 5 tons of seed to neighbouring territories. In addition irrigation has been installed for the production of vegetable seed by Government on 12,00–1,500 dunums (276–345 acres) at Acre. Consideration is also being given to the construction of additional storage plant, both central and in settlements, and to dehydration. It should be possible to build up a substantial reserve and enable seed firms to establish an export trade. The biggest problem at present would appear to be the conservation of seasonal surpluses of vegetables for lean periods and the safeguarding of the grower.

(D) Jamaica.

A memorandum recently received on the hill trials in Jamaica indicates the possibility—subject to setbacks due to climatic vagaries—of producing seed of most vegetables in Jamaica. It is suggested in the memorandum that, while this might facilitate the selection of vegetables peculiarly adapted to the Island, on economic grounds the commercial production of vegetable seed is not desirable.

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